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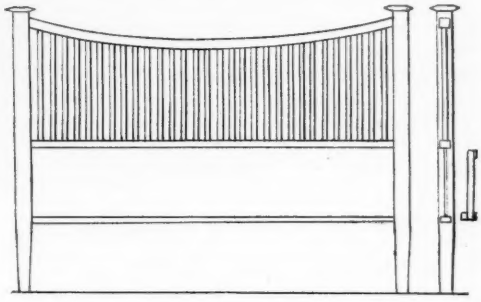
AN ATTRACTIVE BEDSTEAD.

JOHN F. ADAMS.

The bedstead here described is an English design which appeared in the early part of the 19th century, and has a light yet strong appearance, which is very attractive. For a dark wood mahogany is the most suitable, and as the required quantity of lumber is not large, the cost for same would not make it at all expensive. Or bird's-eye maple, with light pearl stain, would be quite pleasing and would be out of the ordinary effects.

The head and foot boards are alike with the exception that the headboard is 6 in. higher that the footboard. The corner posts are 2 1/4 in. square and are 3 ft. 10 in. and 3 ft. 4 in. long, respectively for head and foot boards. The bottom ends are tapered down to 1 3/4 in. square, the taper beginning 10 in. from the ends. They are 4 ft. 6 in. apart, and allowing 1 1/2 in. on each end for tenons the top rail is 4 ft. 9 in. long, 1 3/4 in. wide and 1 1/2 in. thick. The curve in these pieces reduces the lineal length by 2/3 in., so the mortises in the posts are only 1 1/4 in. deep and 1 in. wide. It will be best to have the rails steam bent, as otherwise the assembling will be a vexatious matter. If steam bending cannot conveniently be done, the rails can be clamped down to a piece of rough timber, blocking up the center 3 in., and the mortises for the spindles cut to the proper angles.

The spindles, 30 in number, are spaced 1 in. apart, and require 30 pieces 3/4 in. square and 38 in. long; these being cut to give the long and short pieces for head and foot boards. The pieces at the bottom of the spindles are 4 ft. 7 1/2 in. long, allowing 3/4 in. tenons on the ends, 1 3/4 in. wide and 1 1/4 in. thick. In addition to the mortises for the spindles cut in the top sides, grooves 3/8 in. wide and deep for the panel board are cut on the under side. This can best be done with a 3/8 in. grooving plane, a wooden one costing but little and is always a handy tool for cabinet work. The pieces under the panel boards are the



same length and width as the pieces above, but are only 1 in. thick. Grooves are cut on the upper sides of these pieces. The tenons on the ends are 1 in. wide and 3/4 in. long. The panel board is 4 ft. 7 in. long, 10 1/2 in. wide and 3/8 in. thick, grooves 3/8 in. wide and 1/2 in. deep being cut in the posts between the mortises for the pieces above and below it. All grooves and mortises are centered in the pieces in which they are cut.

The sideboards are 6 ft. 2 1/2 in. long, and require two pieces 10 in. wide and 7/8 in. thick; four pieces of moulding 1 in. wide along the top and bottom outside edges, and two strips 1 1/2 in. wide and 3/4 or 7/8 in. thick, on the lower inside edge in which are cut slots for the bed slats. By inspecting any wooden bed, the spacing and dimensions of the slats may be obtained; the slats may be purchased of any furniture dealer. The moulding mentioned should be a plain pattern without sharp edges, which would splinter or break off with wear, and is fastened on with glue and wire brads.

It would also be advisable to bore holes and drive wire nails through the tops and bottoms of a few of the spindles, to hold the top rails from lifting away from the spindles. By cutting off the heads of the nails only small holes will be needed, which can be fitted with stained putty, using an oil stain. The tenons on the rails and pieces above and below the panel board should also be similarly pined with larger nails or wooden pins.

The tops of the posts are covered with caps cut from pieces 3 1/2 in. square and 3/4 in. thick; the edges being beveled off to a thickness of about 1/8 in. Shallow mortises fitting the tops of the posts are cut on the under sides of these caps, which are fastened in place with glue and a few long wire nails of small gauge.

The hangers for the sideboards should be a kind which can be attached with long screws, as it is a difficult matter to put in the kind commonly used on wooden beds, unless one has a small circular saw with which to cut the slots. The castors most appropriate are those having square ferules covering the ends of the posts, but whatever castor is used should have a screw plate large enough to prevent undue strain on the post, else it might be split when moving the bed about for house cleaning. The ball bearing castor which does not require cutting into the post is quite suitable. The materials for this bed will cost from $8 to $10, depending upon the price paid for the lumber.

INVENTORS SHOULD CONSIDER.

The young man who has, or thinks he has, made an invention has need of much sense and sound advice before he puts any appreciable amount of either time or money into his invention, says Irv. in "American Machinist." Otherwise, as soon as he sees he has something which he thinks is to revolutionize the particular class to which it belongs he rushes off to a patent attorney with a rough model of the device, is assured that no doubt a valuable patent can be secured for the invention, and then begins a series of expenses and disappointments which end in a poorer but wiser young man.

The inventor should not let his invention run away with his common sense. He should look for criticism rather than praise. He should weigh carefully its bad points as well as its good ones. Great blame is laid, and rightly, at the doors of unscrupulous patent attorneys, but the stubborn, bound-to-go-ahead inventor has made it possible for such attorneys to do a thriving business. The attorney who is honest enough to suggest that the invention is patentable, but that the patentable part is so small and easy to get around, that it will be throwing money away to take out a patent, is likely to be looked upon with either suspicion or scorn, and see the patent taken out by some less honest competitor.

The young man who has invented or intends to invent should carefully consider several things. He should confine himself to the class of work with which he is familiar. When he has made one invention he is liable to think that he can take a casual glance at most any line of work and improve upon it, but many have tried it to their sorrow. He should carefully consider whether the device is worth patenting, and not whether the device can be patented. There are several ways of arriving at a fairly accurate answer to this all-important question. In the first place, is the new device an improvement on that which is already on the market? Is it simpler? Is it cheaper? Is it so much better that a buyer would be willing to pay a little extra in the way of a royalty over the old device? Let the inventor put these questions to himself, weigh them carefully, and answer truthfully. But even if he can say yes to these questions or to most of them, let him not be satisfied with that. It is essential that he should next find out what others have done along the same line. This is not so difficult as it may seem. For the sum of ten cents he can obtain from the Patent Office a copy of the Classifications of Inventions, giving all the classes and subclasses into which the United State patents are divided. Having ascertained the sub-class in which the device would be classed, let him write and find out the cost for one copy of each patent contained therein. If the cost is not great he should get them by all means. He may find the same thing or a dozen better, and be saved the expense and disappointment of going ahead blindly and obtaining a patent at considerable cost which will be as easy to get around as falling off a log.

The best way of all, is for him to first buy the patent papers and study them carefully. Then let him improve on what he finds there. If he cannot improve on what he finds there, he will do well not to go ahead with a vague idea that in some unaccountable way, to be revealed in the hereafter, the sound-headed business man is going to pick out and adopt the invention disclosed in his patent even though it isn't quite so good as some old patent which can be used without any payment of royalty.

DESIGN OF A 12-INCH INDUCTION COIL.

WM. B. EDDY.

The aim of this paper is to show the application of the principles of induction coil design, taking for illustration a 12-in. coil. It is not to be expected that an amateur without experience or a study of the work of others should be able to design an effective and efficient coil, since there is no definite and fixed course that can be followed to obtain a desired result. Therefore, in many places it is necessary to accept the experience of others as well as using "cut and try" methods.

The design below is for a good all round coil for laboratory use, one that will give a good spark with a small amount of current, and which will also deliver a comparatively large amount of power when required; a coil that can easily produce a 12-in. spark.

THE COIL.

We will begin the design for such. The core will be made 2 1/8 in. diameter by 24 in. long, composed of a bundle of No. 22 iron wire well annealed. Several writers advise a core 1 1/2x19 in. for a 12-in. coil, but a more powerful field than such a core can produce will be obtained from the core selected. The diameter of the core selected compared to its length is about 1 to 11 1/3, which is a good ratio for such a coil, and will allow the use of a high speed interrupter when desired.

The primary will be wound with about two and a half layers of No. 12 double-cotton-covered wire. This will give the maximum number of ampere turns which will probably ever be required and the winding for the last of only a half layer will enable one to bring out the taps without inconvenience; the extra flexibility of this arrangement compensating for the space wasted at the end of the half layer.

From wire tables it is found that there can be wound about 10.4 turns of No. 12 double-cotton-covered wire to the inch, so if an inch of space be allowed at each end of the core 230 turns can be wound in the

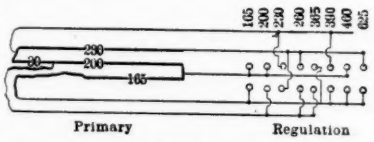


FIG. 1.

remaining 22 inches. The layers will be made continuous by bringing out a connection at the end of each layer and tapping the second at the end of 30 turns and winding only 165 turns for the third layer. Two thicknesses of impregnated paper between layers will be sufficient for insulation.

The sketch of Fig. 1 shows diagramatically the arrangement of these layers and taps; the variable inductance feature may be worked with either switches or plugs to obtain any one of the 8 combinations. These connections cut into the primary circuit the following numbers of primary turns—165, 200, 230, 260, 365, 395, 460 or 625.

THE INSULATING TUBE.

Before determining the thickness of the insulating tube it is necessary to find the voltage that this tube must withstand.

Curve A of Fig. 2 shows the ratio of spark length to voltage in air between needle gaps as determined and used in high-potential transformer testing; but this voltage is as read by an alternating-current instrument and is based on a sine wave, the meter registering "root mean square" values. The ratio of the maximum is to this effective value for a sine wave as 1:1/12 Since it is the maximum value which determines the sparking distance, curve B has been drawn to show

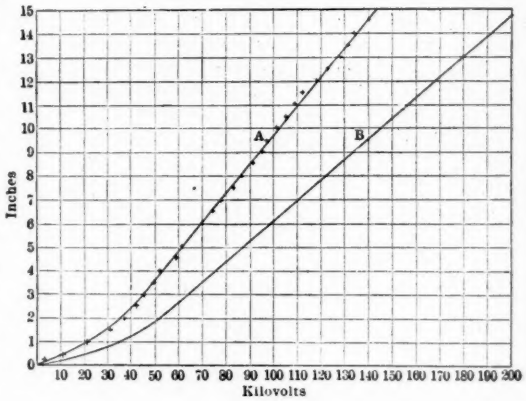


FIG. 2.

these maximum values. The abscissas of this curve represents potentials and the ordinates represent sparking distances and the potential in kilovolts can be read off directly from the curve for any spark length in inches.

It will be seen from curve B that the coil which must give at least a 12-in. spark must withstand a potential of about 170,000 volts. Experience has shown that it is necessary to insulate for only 3/4 of the maximum spark length, which in this case would mean about 130 kilovolts.

Hard rubber, or ebonite, will be selected for the material for the insulating tube, and from Table I it is

seen that the rupturing voltage for this substance varies from 900 to 1500 volts per inch of thickness. If the lowest value given be used and a factor of safety of 4 be taken on a safe value of 175 kilovolts per inch, a thickness of 3/4 in. will be required for the insulating tube. The length of this tube for a 24-in. core should be at least 26 in.

The inside diameter should be such that the primary and the core will fit snugly inside of it. The layers of the primary, even with the insulating paper between them, will fit into each other to a certain extent, each turn falling between two turns of the adjacent layer; therefore if the paper is .006 thick and two thicknesses be put between each layer and the next and a half dozen or more between the primary and the core, at least 5/8 in. inside diameter must be allowed for the primary. This will give 2 3/4 in. for the inside and 3 1/2 in. for the outside diameter of the insulating tube.

It has just been found while calculating for the insulating tube that a secondary potential of 170 kilovolts will be encountered. There must be therefore such a number of secondary turns as will, under normal working conditions of the primary, give this potential.

From 50,000 to 80,000 turns represents good practice for a 12-inch coil. Simple calculations will show that at the primary tap giving 260 turns, which is a fair working point, and with an interrupter working on direct current giving an effective e. m. f. across the primary of 40 volts, the number of secondary turns for 170,000 volts should be 55,000.

The above calculations assume that with the given design of coil all the secondary is wound in the most effective part of the field and a large current is used such as would fully magnetize the core before "break." It is desirable, however, with the present design to obtain the spark with a comparatively small amount of current and it is preferable, therefore, to take advantage of data obtained from experience in the construction of other coils and use somewhere in the neighborhood of 70,000 turns.

For the secondary wire No. 34 is best adapted. It is best also to wind the sections in "pies" of 1/8 in. thick. This size of wire can be wound after it has been through a bath of hot paraffin wax, on an average of about 912 turns to a pie of cross section 1/8x1 in. and by a cut-and-try method it is found that 70,000 turns can be placed in 60 pies having an average cross section of 1/8x1 3/8 in. The secondary winding should have about 1 in. for insulation between it and the insulating tube, to prevent the spark from jumping to and across the surface of this tube. At the ends of the coil where normally the potential is highest this insulation should be increased. Thus the insulation between primary and secondary would resemble a series of steps from the centre outward.

Applying these additional considerations to the calculations of the number and size of the secondary pies, the design will be as follows:

18 pies 4½-in. int. diam. and 1½-in. cross sec'l length.
18 pies 4⅝-in. int. diam. and 1⅜-in. cross sec'l length.
24 pies 4¾-in. int. diam. and 1¼-in. cross sec'l length.

giving 60 pies and approximately 74,000 turns.

This will give a uniform outside diameter of 6 in. which is in good proportion for a 12-in. coil with the chosen core dimensions.

It is proper to assume that the laboratory coil will sometimes be used with condensers across the secondary and that it will be desirable to choke back high frequency oscillations. For this purpose there will be added two coils at each end wound with No. 28 double-cotton-covered wire, to the same thickness, and external diameter as the other pies and 4 3/4 in. internal diameter. This will add less than 1000 turns; so that there will be approximately 75,000 turns on the secondary.

Even when wound with less than 60,000 turns on the secondary, the above coil would give a 12-in. spark but would require, when tested under the same conditions in the primary circuit, one-third more current than the present coil; while a coil wound with about 53,000 turns of the same size wire, cotton covered and thus more wasteful of space, would require one-half more current, using in each case a Wehnelt interrupter.

TableI.—Rupturing E.M.F. in Kilo-Volts per Inch.

Substance.	Rupturing e.m.f..
Ebonite	900—1,500
Glass	500
Window glass	380—1,000
Gutta percha	250—1,000
Mica	1,500—5,000
Micanite	2,500—7,500
Paraffin wax	330— 650
Petroleum	230

Impregnated paper:—

Thickness.		
.0047	1,000	Thin printer's paper.
.0035	1,300	Tisue paper.
.0071	1,100	Manilla paper.
.0051	1,600	American linen paper.
.0055	1,350	Linen typewriter paper.

Boiled-out linseed oil	215
Light mineral lubricating oil	120
Paraffin oil sp. gr. .28	165—250

With the same dimensions a coil for wireless telegraphy work would have required a primary with three complete layers of No. 10 wire and No. 32 for the secondary, wound more effectively since the smaller number of turns for an equal bulk of this wire would give a lower potential, which would require less space for insulation. The coil could probably no longer be rated at 12 in., but it would be far better adapted to heavy wireless work, because of the decreased resist-

ance of a shorter length of larger secondary wire and the increased ability to handle a large volume of current. Since in this class of work an extremely rapid interrupter is not advantageous, the coil could have been improved by making the core of larger diameter and thus increasing the amount of iron, thereby having in common for the two coils only the length of the core.

In joining up the separate pies the insides and outsides of consecutive coils should be connected together with the necessary thickness of insulation between them. When dealing in such large numbers and using factors of safety of 3 or 4 it is necessary to estimate only approximately, and slide rule calculations are wholly adequate for most of the preliminary work.

Assume that the impregnated paper between the pies has a thickness of .006 in. per sheet. This insulation must withstand, for the method of connection which has been chosen, double the potential generated by a single pie, or 6000 volts, roughly. From the accompanying table it is seen that this paper will rupture at 1200 volts per 1/1,000 inch. Using a factor of safety of 4 there will be obtained 1800 volts per sheet, which would require four sheets between each pie or section.

The winding will now take up 60 pies × 1/8 in. each = 7 1/2 in. and another 1/2 in. for the four end coils, making 8 in. Four thicknesses of paper × .006 in. per sheet × 64 coils = approximately 1 1/2 in. for the total thickness of the paper and 9 1/2 in. for the entire secondary. It has been found that a good length for the secondary might be considered that of the sparking distance of the coil if it is desired to err on the side of safety and have the least danger of the spark jumping inside of the secondary or across the surface. To prevent this on the outside it is necessary to increase the thickness of the insulation if a short secondary is used, and this has its disadvantages. In the coil being designed it is desirable to make everything as immune from breakdown as possible, and therefore another two or three inches will be utilized for insulating purposes.

From the manufacturers' standpoint, paper discs are a more expensive insulation than the wax in which coils are imbedded, so that it might be well to increase the number of paper sheets from 4 to 6 and use the rest of the space for insulating compound, or for oil if the coil is to be immersed. It is convenient to cast the secondary in a number of sections, and between these sections the remaining space will be distributed. The paper discs should extend beyond the winding at both the inside and the outside diameters.

It will now be interesting to compute the length and weight of the secondary winding. The average diameter of the larger pies is 5 1/4 in., which multiplied by N/12 gives 1375 ft. for the average length of one turn; 1375 ft. × 18 sections × 1368 turns per section = 33,900 ft. for the number of feet of wire in the larger sections in the center of the coil. Computing in the same way there are obtained 31,400 ft. for the intermediate and 38,600 ft. for the end sections, making a total of 103,900 ft., or about 19 3/4 miles of No. 34 wire weighing about 15 lb., and having a resistance of about 27,000 ohms at 20° C. The four end coils add a weight of about 1/2 lb. of No. 28 wire. The primary contains over 400 ft. and weighs over 10 lb. and the core will weigh about 20 lb., so that the wire and iron alone in the coil weigh nearly 50 lb. without insulation or mountings.

THE CONDENSER.

Working with a Wehnelt interrupter the coil will require no condenser. With a slow vibrating hammer break and heavy current it should not require more than one microfarad of condenser capacity. The capacity should be made adjustable for different conditions of working and different currents and interrupters.

The formula for the capacity of a condenser in microfarads is

$$C = \frac{885 \times \text{effective area in sq. cm.} \times K \times 10^{10}}{\text{thickness of dielectric in cms.}}$$

If the same paper is used as before, .015 cm. thick, there should be two sheets, which will make a thickness of .03 cm., and from

Table II.—Average Specific Dielectric Capacity

Air	1
Ebonite	2.5
Glass	
Flint	5—10
Crown	3—6
Gutta percha	2.7
India rubber	2.3
Mica	6.5
Shellac	2.8
Sulphur	3—4
Paper impregnated with paraffin	3.7
Paraffin wax	2
Petroleum	2.5
Turpentine	2

18	4 1/2	1,368	24,624
18	4 5/8	1,254	22,572
24	4 3/4	1,140	27,360
4	4 3/4	175	700
—			———
64			75,256

Table II. it is seen that the value of K for this paper is 3.7. Let us now find the capacity per sq. ft. of active surface. One sq. ft. = 930 sq. cm.

$$C = \frac{885 \times 930 \times 3.7 \times 10^{10}}{.03} = .01 \text{ m. f.}$$

Thus one can easily calculate the number of sheets of foil and paper for any desired capacity by taking the value of .01 m. f. per sq. ft.

SUMMARY OF RESULTS.

Core, 2 1/8 in. by 24 in.; insulating tube, 26 in. by 2 3/4 in. inside diameter by 3 1/2 in. outside; primary,

2 1/2 layers No. 12 wire, 230 turns per layer; secondary, No. 34 wire wound in 1/8 in. sections, each 6 in. external diameter.

Number of Sections.	Inside Diameter.	Number of Turns.	Total No. of Turns.
18	4 1-2	1,368	24,624
18	4 5-8	1,254	22,572
24	4 3-4	1,140	27,360
4	4 3-4	175	700
64			75,256

The above coil when worked on with direct current at 110 volts with a Wehnelt interrupter will give a 12-in. spark on about 12 amp. of current, using 165 primary turns, and a 14.5-in. spark using 13 1/2 amp. The secondary terminals should be so placed as not to allow a greater spark than 14 1/2 in. Using two full layers of the primary winding and 10 amp. of current there can be obtained a heavy and powerful discharge across an 8-in. gap.—"Electrical World."

GRINDING GAS ENGINE CYLINDERS.

I have found, what I suppose everyone has who has had much to do with gas engines, that the finish and truth of the cylinder bore, piston and rings should be the very best possible. To attain this perfection I have designed and made for my own use two different rigs to grind the bore of cylinders. Fig. 1 shows a rig for the lathe that does the work well. The drawing is not to scale, but shows the idea, and any machinist can work out the details. A is a chuck which centers and holds one end of the cylinder, the other end being centered in the revolving steady rest B. C is the revolving part of rest carrying the four jaws D, which center and hold that end of the cylinder. E is a gray-iron casting that bolts to the cross slide of the carriage and has a gib under the bar F bolted to the carriage. When set for the cut the gib can be set up, making all rigid. The casting E has through its center, running in bearings, a shaft carrying an emery, corundum or carborundum wheel at one end and a driving pulley at the other. G is the end of a casting from the same pattern as E. The end is counter-bored to receive a machinery-steel piece slotted across the face to receive a square piece of tool steel. A set-screw holds the end piece from turning and a long steel bolt with a hole at one end and a nut at the other holds the cutting tool secured. This is used for boring. Fig. 2 shows a grinding bar to use between the centers of the lathe when the work is secured to the carriage and bored with a boring bar. It consists mainly of a gray-iron casting A with a drived fitted to it; the larger part is cored out and has a flange at the end. The core cutting through at one side in the middle, as shown, allows the grinding wheel to project. This casting is bored and the flange finished all over and then secured by three solid studs to another flange carrying a short shaft. Of course this short shaft should be re-centered and finished in perfect alinement after the studs are fitted. This shaft carries a pulley running loose, to which is secured an internal gear B, which drives a rawhide pinion secured to the shaft of the pulley C, a belt from which drives the grinding arbor. A larger view of the flange of A shows the means for adjusting the grinding wheel. A casting D is turned to fit nicely the bore in A. D is bored eccentrically to receive a casting E, which carries in proper bearings the grinding-wheel arbor. These castings are made in skeleton form to save weight as much as possible. A steel piece F is fastened to the flange and in it slides a steel piece G that fits into a counter bore in E, the grinding arbor passing through it. A tangent screw is provided for fine adjustment. The construction and use of it is too obvious to need any further description. A bearing H is secured to the bed of the lathe and adjusted to relieve the center of any belt pull. J. S. Rounce in "American Machinist."

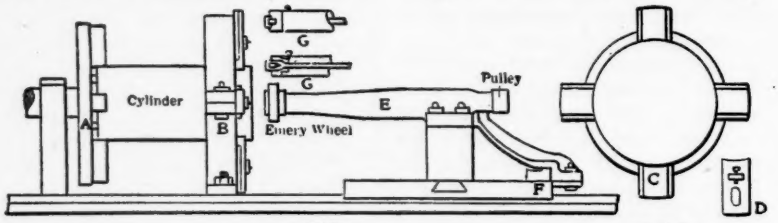


FIG. 1

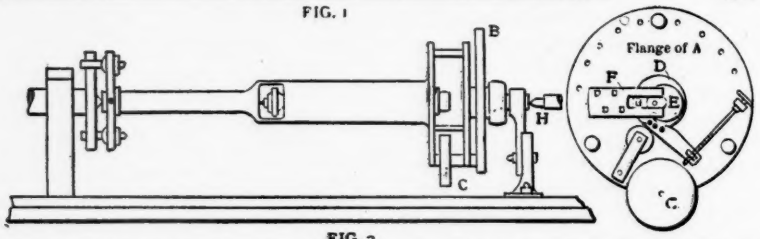


FIG. 2

DECORATIVE ENAMELLING.

I. Kinds of Work and Utensils Needed.

There are few of the artistic crafts more fascinating than enamelling, and certainly none more beautiful. To enter into the work seriously a muffle furnace is required, but small pieces of work in both Cloisonne and "Limoges" may be done in a crucible, with a large blowpipe or in a large methylated-spirit flame. Small articles of jewellery may easily be enamelled, and a considerable insight into the work may be gained with a comparatively inexpensive outfit.

The process consists of coating the surface of copper, silver or gold with a layer of melted glass. The glass is made from silica, red-lead and potash, either carbonate or nitrate, and in various proportions, which form, when in combination, which is produced by melting in a crucible, a flux. The flux is transparent and colorless, capable of adhering to either of the above metals without cracking after it has been fused or melted. The coloring is done by the addition of various oxides of metal and made opaque by means of tin or lead. The principal oxides used are those obtained from gold, copper, iron, cobalt, manganese and antimony, the gold oxide giving ruby; copper, both green and turquoise blue; iron, brown and orange; cobalt, ultramarine blue; manganese, purple; and antimony, yellow. It is possible to mix them together, and they will combine similar to water colors. Enamels require a long heating, anything from five to thirty hours continuous melting; the harder enamels being those which require the greatest heat to melt and which are certainly the best to use, although it is very convenient to have a soft enamel, which will melt or "run" at a fairly low temperature.

The different methods of using enamel are as follows:—Cloisonne; Champleve, Plique-a-jour, Bassitaille and Limoges or painted enamel. The first process on the list will be found most useful for general purposes, and will be very fully described. It may be considered as a method of filling up small spaces made on a piece of metal by means of narrow strips, with enamel ground to a fine sand, and then fused in a furnace crucible, or in a spirit flame, according to size, the amount of heat required depending on the hardness or softness of the enamel used. The metal strips of rectangular wire are called "Cloisons," hence the name cloisonne, and the enamel is usually opaque; these cloisons are not necessary to hold the enamel together, but should be used to form the design, for the enamel adheres quite as well without the cloisons as with them. Champleve-enamelling consists in carving out of a thick piece of metal different spaces which will form a design, leaving the edges of the spaces to form the outline, if necessary, of the ornament. Into these spaces, opaque, or sometimes transparant enamels are run, which form the design. The work requires great skill in cutting out the spaces and the best metals to use, either bronze or very hard brass. It will be noticed that both the above processes are similar, the difference being mainly in the method of making the spaces which, in cloisonne are built up with soldered walls of thin metal, and in Champleve are sunk below the surface, the metal itself forming the divisions.

FIG. 1.

The method of applying the enamel and firing it being the same in both cases, there will be no need to treat them separately. The next process, that of Plique-a-jour, is somewhat similar to thee above, but without a back, and is really a method of enamelling the spaces between a network (as the word means) of gold, silver or copper wire, and it may be considered as cloisonne without the necessity of keeping the neamel in place while it is being fused, the method being to place the work vertically in a very fierce muffle. The work may consist of soldered pieces of wire forming a suitable design, or as is more often the case, the spaces are cut away with the fretsaw, and the divisions left in the metal itself. Very beautiful effects can be gained by this process, which is very fairly light and delicate, and it is well worthy of a trial. The next process, Bassitaille, is not a commonly-practised method, mainly on account of the great artistic skill and technical knowledge required. The word means "low cut," and the effect is gained by carving out the design, sunk below the level of the metal usually, in low relief, or in repousse, in high or low relief, and then the metal is entirely covered, both sides, with transparent enamel or enamels, allowing the details of the carving to show through the enamel. It is a very beautiful process, but as it is usually in gold, and is seen to its greatest advantage with that metal, it will be found rather too expensive for ordinary art workers.

The remaining process to be described is "Limoges" or painted enamel, so called because it was first practised at Limoges, about the end of the fifteenth century, and the enamelling is done in the simplest and most straightforward manner, compared with the difficult and tedious preparation of the metal in the methods described above. Very small articles of jewellery may be made by this process, but it is in the painted panels of some few inches in area that the finest work is seen. The enamel is ground down to a fine powder, mixed into the consistency of paint, and then used much in the same way as water colors, the work being somewhat limited, but making up in depth of color what it lacks in tints. The subject is painted on a domed plate of copper, which is covered with a ground of enamel, black, blue or some suitable color. Upon this ground the painting is done in semi-transparent white enamel, known as grisaille. The grisaille is fired, other enamels of various colors are painted over and again fired.

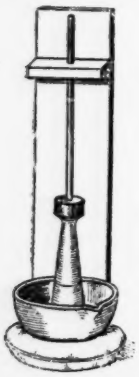


FIG. 1.

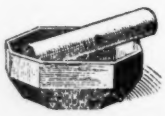


FIG. 2.

To make satisfactory Limoges enamels, considerable practice in enamelling is necessary as well as artistic taste and skill. Of all the above processes, those most useful to the artworker who wishes to make jewellery are Cloisonne, Chempleve and Limoges, the others being left with advantagee until the easier methods have been practised.

We shall therefore describe these three processes in turn, for the reasons which we have given, commencing with the more simple methods of work, and Cloisonne being perhaps the most useful of the three, will be the best to begin with. The first thing to be considered is, or course, the enamels, and they are purchased in all colors similar in form to lumps of glass.

It is quite necessary to know how to prepare the enamels, so the process will be described. The required piece of enamel is taken and pounded up into small pieces, in a mortar, with a pestle having a wooden handle(Fig. 1), a Wedgewood No. 3 size costing about 2s. 3d., or a porcelain of the same size only 1s. 6d. A wooden mallet will be necessary in beating the pestle to thoroughly pulverise the glass, but of course great care will be needed that the side of the mortar is not broken. The pestle should be held directly over the pieces of enamel, and the blow given exactly on the head of the pestle. As soon as the enamel has been reduced to a coarse grit, it should be further reduced, and this is done by grinding it to a fine sand; the pestle is held firmly in the right hand, and holding the mortar in the left, rotate the pestle until it is sufficiently ground. Considerable pressure is required, and a contrivance similar to that shown in Fig. 2 will be found very useful in easing the work. A long iron rod should be fitted either into the top of the pestle, and a bracket fixed either to the wall or to the bench, and through the top should be passed the other end of the rod; lead weights may be placed on the rod resting on the top of pestle, and any pressure almost may be exerted on the pestle. It will be seen that the water becomes cloudy as the grinding progresses, so that the enamel should be washed, if it is transparent, but not if opaque, and the washing is done by agitating the sand while in the mortar, and continually changing the water. The fluid may be poured into jars and allowed to settle, the residue being used for backing the plates, for the enamel is useless for anything else, being opaque and cloudy.

For Limoges work the enamel will have to be ground to a powder in an agate mortar (Fig. 3), but this will be rather expensive, for the smallest agate mortar, with pestle, costs $1.00, and is only 2 inches in diameter, and the larger sizes about 4 inches, costing $5.00 or so. It is quite necessary, if really good work is to be done, to invest in this piece of apparatus, for the trace of foreign matter will spoil an otherwise good enamel.

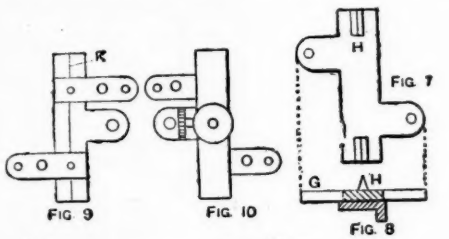
It is much better to use enamels as soon as they are ground, but if this is not possible, then keep them in jars under water and then not more than a week or so, or else in bottles securely corked. If the powdered enamel is old, or has been exposed to the air, it will become disintegrated, but where it is necessary to use it, it should be washed for a few minutes with weak hydrofluoric acid, about 1 part to 12 parts of water, and then, after washing away all trace of the acid, it may be used. Great care must be taken in using this acid, as its fumes are highly poisonous.

While tungsten is considered one of the rare elements, tungsten compounds are of considerable use. Sodium tungstate is largely employed for impregnating fibers to make them fire-proof. It is also used as a mordant in dyeing. Tungsten bronzes are largely employed as bronze powders and pigments. The chief consumption of tungsten in recent years has been, however, for highspeed tool steels and for hardened steel for armor plates and large guns.

SOUND BOX FOR GROMAPHONE.

This article describes one of the latest forms of sound-box for a gramophone. The details can be slightly varied to meet requirements, but the general design and dimensions should be adhered to, as the instrument is the product of much experiment. The whole of the work can be carried out with hand tools, but the slide-rest is desirable. The illustrations are reproduced full size.

The body (Figs. 1 and 2) and the ring (Figs. 3 and 4) are brass castings; the patterns must allow for shrinkage and machining. Mount the body on a face



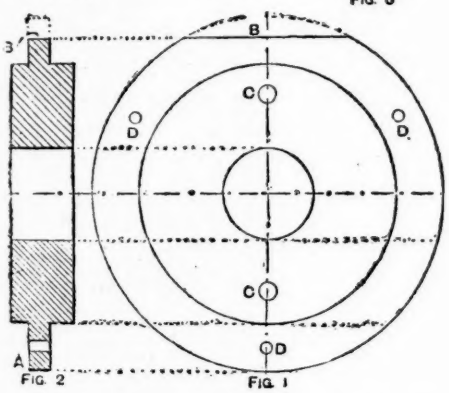


plate or in a recessed hardwood chuck, bore out the centre to 9/16 in., and face up. Remount on a truly turned spindle, and finish both sides and rim to the dimensions as follows: Greater diameter 2 1/16 in., lesser diameter 1 1/2 in., thickness of latter 3/8 in., thickness of central flange 1/8 in. Then scribe lightly a circle exactly 2 in. in diameter on the face of the flange at A (Fig. 2). Remove from the chuck, grip between lead jaws in the vice, and file the flat B (Fig. 1) to within 1/8 in. of the lesser diameter. The holes indicated should be bored, the two at the back of the body C (Fig. 1) to a depth of 1/4 in., and tapped 1/8 in. thread (see Fig. 5), and the three D, in the flange, 3/64 in. clearing. The ring (Fig. 3) is a light casting, and is conveniently chucked in recessed hardwood and the face machined. Then reverse and tool out the recess E to 1 3/4 in. diameter and 1/4 in. deep, leaving a flange which when finished is 1/64 in. to 1/32 in. thick, its inner diameter being 1 5/8 in.

Re-chuck on a hardwood mandrel that fits the recess accurately, and turn the rim to 2 in. in diameter, its width being 1/4 in. full to 9/32 in. While still in the chuck, file the flat F (Fig. 3), leaving 1/15 in. substance to the recess. Then remove from the chuck and hard-solder on the fitting G (Figs. 3 and 6), which is of 3/16 in. brass, 7/8 in. long, 1/4 in. wide, and 3/4 in. over the lugs. A plan and elevation of the fitting G is shown by Figs. 7 and 8. The small knife-edge projections H (Figs. 3 and 6) are 1/8 in. wide and 1/16 in. high. They can be formed in the material by filing or planing, in which case 1/8 in. brass must be used; or they can be riveted into the 1-16 in. metal and trimmed up. The holes, tapped 3/64 in., are spaced 3/8 in. apart, in line with, and 5/8 in. apart across, the ring. The body (Fig. 1) and the ring (Fig. 3) are now assembled by the scribed gauged circle A (Fig. 2) the screw holes D marked, bored, and tapped in the ring 3/64 in. by 1/8 in. deep as at J (Fig. 3).

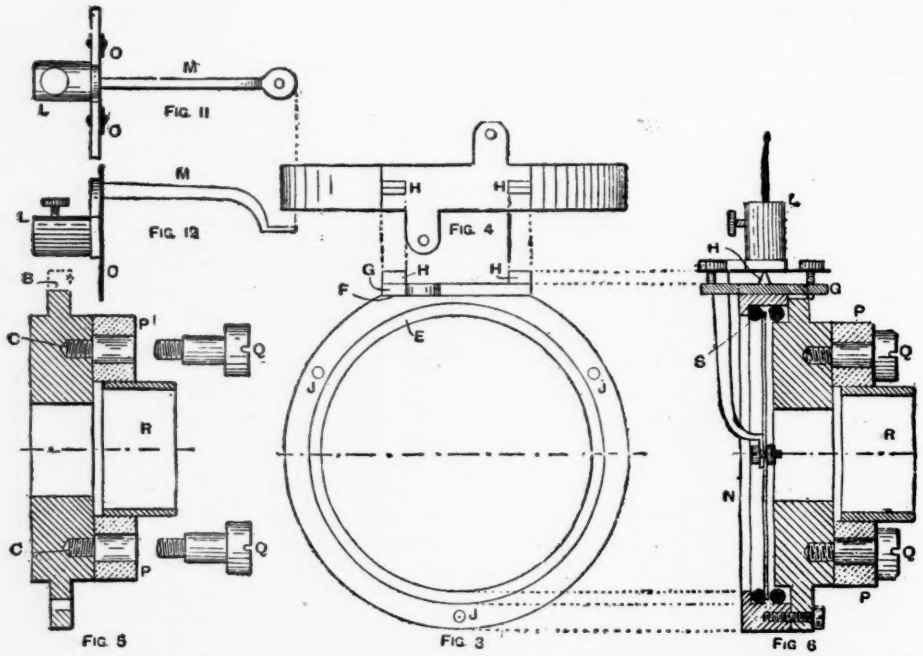
The fiting, shown by Figs. 9 to 12, is now built up and hard-soldered together. The base, of 1/16 in. brass, is 7/8 in. long, 3/16 in. wide, and 7/16 in. over the central lug. It has a shallow saw-kerf centrally on its under side as at K (Fig. 9) to engage with the knife edges of the ring fiting G. The needle socket is of 1/4 in. brass rod 3/8 in. long, bored to suit the needle shank and tapped at the side 3/64 in. for the set screw.

The diaphragm finger M (Figs. 11 and 12) is 1 1/16 in. long from the under side of the base to its central hole; it is of 1/16 in. brass, and tapers from 3/16 in. to 1/16 in. at its terminal disc, through which, and the talcum diaphragm N (Fig. 6), passes a small screw, nutted at the back of the diaphragm. Two pieces of steel, or hard brass, spring 1/2 in. long by about 1/8 in. wide are riveted to the base, as shown at O (Figs. 9 to 12), equidistant from its centre and 3/8 in. apart. In the ends 3/64 in. holes are bored, to correspond with those in the ring plate G. When attached, these springs are bent equally towards the needle socket L, so that when the screws are passed through them, an equal tension can be exerted on the diaphragm finger M.

A disc of rubber P (Figs. 5 and 6) 1 1/2 in. in diameter and 1/4 in. thick, with a 3/4 in. hole in its centre, is attached to the back of the body with two 1/8 in. cheese-headed screws Q 1/4 in. plain under the head. Into the central hole is cemented a 7-16 in. length of brass tube R having a 11/16 in. bore. This tube must not be in direct contact with the body, the object of the

rubber being to insulate the vibrations of the sound-box from metallic connection with the tone-arm or trumpet.

Fig. 6, which is in part section, is intended to facilitate the assembling of the parts. Before this is done, the work should be polished and lacquered, or nickel-plated. First secure the rubber buffer P and the tube R to the back of the body (Fig. 1). Then loosely attach the finger fitting (Figs. 9 to 12) to the ring (Fig. 3).



Select a good mica disc N of 1 11-16 in. diameter, and bore a fine hole in its centre. Cut a length of 1/8 in. rubber tube, with scarfed ends, to neatly fit the recess in the ring. Lightly dress the edge of the diaghragm with adhesive, and place it on the rubber within the cell, working it carefully to a central seating, not touching the cell at any point. Apply light pressure and set aside to dry; do not stick the gasket to the flange. When set, fit a second rubber gasket to the back of the diaphragm, without adhesive, and assemble the body and the ring by the three screws to fit the holes D, when the two rubber rings S will evenly and closely grip the diaphragm N. For the sake of clearness, the rubber tube gaskets S are shown conventionally, in Fig. 6, as black circles. In practice, of course, they will flatten under pressure, and spread considerably.

The finger fitting is now gradually screwed up, half a turn at a time on each side, until fairly rigid with the main body, the terminal disc just bearing on the diaphragm centre. The small screw is then passed through the finger end and diaphragm, and secured with a small flat nut at the back (see Fig. 6). A speck of hard wax can be melted into the joint, to arrest possible vibration at this point.

The sound-box is now complete, and will be found to weigh between 4 oz. and 5 oz., which is about correct for modern disc records. The tuning-up must be carefully attended to by actual trial on a machine, the tension screws being used for the purpose. Theoretically, the diaphragm should be submitted neither to much pressure nor tractive strain, its own elasticity determining its normal set.

If facilities for brazing and silver-soldering are not available, the joints can be made with soft-solder, using zinc chloride as a flux; but this method is less satisfactory.—"Work," London.

The blood rains of Central Asia and Mediterranean areas are showers of grayish and reddish dust mingled with rain. The dust is largely made up of microscopic organisms, especially the shells of diatoms, the red color being due to the presence of a red oxide of iron. These rains occur where violent huricanes, following periods of drought, carry the dust from dried lake bottoms and river beds into the upper regions of the atmosphere. At times the dust is transported hundreds of miles before it is precipitated, and it may even reach the high altitudes and be carried down by snow in which case the phenomenon is red snow.

THE ENGINEER'S FUTURE.

The electrical engineer of today who has confined his work entirely to theoretical fields has, comparatively speaking, very little chance in competition with his brother worker who, in addition to much practical experience, has been trained in commercial ways. It was not very long ago that the salesman handling electrical apparatus was of the ordinary type, that is to say, his success depended entirely upon his ability as a salesman, and the engineering side of his education, admitting for the sake of argument that he knew the difference between a shunt motor and a rheostat was one of the smaller considerations. Engineers at that time were not considered as possessing the requisite instincts of good salesmen, and such men did not have, and were not expected to have, commercial training. Then there came into the field the theoretically trained engineer, with practical experience in the actual handling of apparatus, and in whom the commercial instinct was strongly developed. In competition with such a man the mere expert salesman had no chance. Slowly but surely the change has been made, and we find that our salesmen of today are all trained practical engineers who are constantly called upon to use their engineering knowledge in connection with their work. We could mention several names today which have become famous simply because the owners, besides being capable engineers, are good business men. These men have interested themselves not only in the engineering of many projects, but have had the financial side under their care, with the direct result that matters entrusted to their attention have turned out successfully. The young man as he comes from college today with his diploma has two serious handicaps. both of which must be overcome before he can be successful even in a modest may. In the first place, he thinks, to use an old explanation, that all it is necessary for him to do is to announce the fact that he is ready to take a position, and then put a placard outside his house, reading to the effect that the line will please form to the right. This clearly is a mistake, and it is not long before the young engineer makes a radical change in his opinion of his own importance. When the immediately expected position at $5000 a year dwindles down to a six months' wait at the end of which he finds $30 a month, the effect is very beneficial, and our engineer "finds" himself. The other point is lack of practical experience, and this experience can be obtained only through years of hard and constant work. To our mind the ideal engineering education would consist of a public and high school training, which would be followed by about two years in college. Then our man should enter upon an appreticeship course, such as can be obtaineed in the shops of several of our largest manufacturers, and should spend at least three years at this work. The remuneration is small and there are many stumbling blocks, but without strenuous work success cannot be obtained. On the completion of his shop course the engineer should go back to college and there finish his education, taking, as the case may be, either one or two years more according to the calendar of his college. If he has in him the inherent qualities of a good engineer he will leave his college a first-class man in every respect. His education may have taken seven or eight years to complete, and he will be pretty well along in years, comparatively speaking, when he is ready to start his life's work, but the time will not be wasted; for such a man the $5000 position is waiting, and the $30 a month job need not enter into consideration. The young engineer should never for one moment overlook the importance of the commercial side of engineering, for without this side the technical part of the business would be non-existent. He may be inclined to consider that commercialism is below him, and if such be his attitude he would probably be better in some other line of work, unless of course he be aiming at a professorship in some college. One of our leading consulting engineers advised us not long ago that every year at the close of the midsummer college term, he receives anywhere from twenty to thirty applicants for positions in his office, and upon advising such applicants to enter shop work or work with a commercial company, has almost invariably received replies to the effect that consulting work was desired. Where such a notion originates is difficult to say, but our colleges should make every effort to eliminate such high-toned ideas from the minds of their graduates. The statement so often made that the electrical profession is overcrowded is absolutely untrue. There are thousands and thousands of $30 and $50 a month men, and a lamentablely small number of five and ten thousand dollar men. For each of the latter there are dozens of positions waiting and there always will be, for the demand exceeds the supply, many, many times. Therefore we say that an engineering education, to be worth while at all, should be complete, and no young man entering college who has made resolutions to really complete his education, fully and thoroughly, need have any fear of his future in electrical engineering.—"Kuhlow's German Review."

The touchstone of the jeweler is known as basanite, a silicious rock or jasper of a velvety, black color. It is used to determine the amount of alloy in gold. the mark of the specimen on the stone being compared with the various known grades of gold.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

IX. Multiple Cylinder Engines.

There are many considerations which make an engine of two or more cylinders particularly desirable. It is a self-evident fact that when the limit of size of a single clyinder is reached, it is necessary to add other cylinders if greater power is desired. Even for moderate or small powers there are many advantages. Among these may be noted the fact that with the proper arrangement of cylinders the impulses may be made to occur at shorter intervals than with a single cylinder engine. Thus with a two cylinder engine the cylinders may be so arranged that the impulses will occur twice for each revolution instead of once as in a single cylinder. This gives a more even turning effect on the shaft and consequently steadier running, and also requires a less heavy fly-wheel. The vibration also is much less, as one set of working parts may be made to travel upwards while the other is travelling downwards, thus neutralizing the throw of each and lessening the vibration.

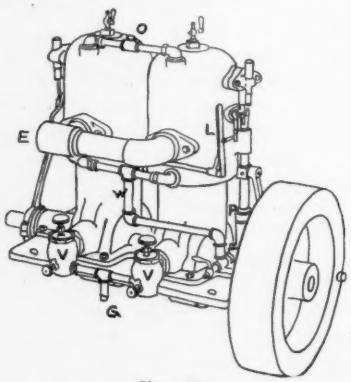


FIG. 59.

In the case also of the disablement of one cylinder there is the chance of getting home on the remaining ones. The weight, power for power, of the multiple cylinder engine is less than that of the single cylinder engine, as the weight of the flywheel and other working parts is less.

While for marine work single cylinder engines have been built as large as eight or ten horse power, they are so large as to be rather cumbersome and the practice now is to build engines of more than six horse power with two or more cylinders. There are several firms who are making double cylinder engines as small as four horse power, which both as to weight and reliability are much superior to those of a single cylinder.

The original method of constructing a multiple engine, and one which is still used by some builders, is to simply use two or more single cylinder engines copuled together. This is a cumbersome method and takes up a great amount of space. The simplest method which can be recommended is that shown in Fig. 59. It consists of two single cylinders mounted on a common base of special design bringing the cylinders much nearer together than when a coupling is fitted to connect two separate engines—as the shaft can be made in one piece. This particular engine is of the two port type, two vaporisers V-V being used. The gasoline enters at G and branches to each vaporiser. The pump is shown at P with the discharge at W, piped with a branch to each cylinder. The cooling water outlet is at O. The exhausts are connected to a common pipe with the outlet at E. The igniting gear for each cylinder is independent and on opposite ends. By means of the lever L, which is connected to both igniting gears, the time of ignition is regulated and kept the same on both cylinders. This allows multiple cylinder engines to be built with very few extra parts, as the cylinders, ignition gear, etc., are the same as in the single cylinder engine.

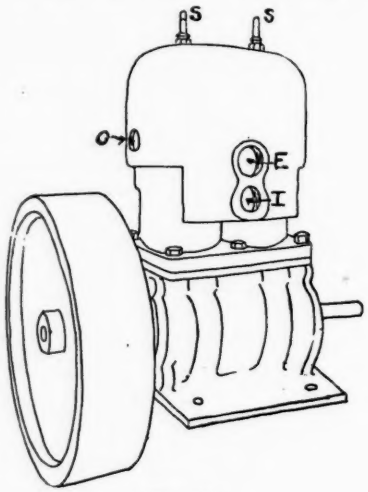


FIG. 60.

A common form of two cylinder engine is shown in Fig. 60. The two cylinders are cast together and bolted to the base. This particular motor is of the three port type with the inlet at I. The exhaust port

is E. The cooling water inlet is at O. the outlet being on the other end of the engine. S-S are spark plugs for jump spark ignition. This engine is of the high speed type, carbruettor and timer not being shown.

In Fig. 61 a four cycle engine of common type is shown. The cylinders are independent, and are bolted to a common base. The carburettor is shown at C

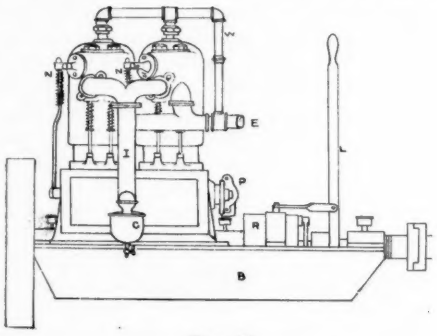


FIG. 61

with the inlet piper I leading up and branching to each cylinder. It is quite important that distance from the inlet pipe to each cylinder should be the same. In this way only can it be certain that each cylinder draws the same amount of mixture.

The cooling water pump is at P discharging water directly into the jackets. This water comes out at the top of the cylinders and discharges into the exhaust pipe E into which the two cylinders also exhaust.

A cast iron base B supports the engine and also carries the reverse gear R. This base holds everything in line and has flanges for bolting to the bed.

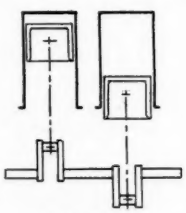


FIG. 62

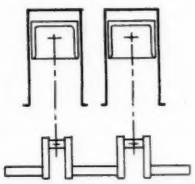


FIG. 63

Three or four cylinder engines are arranged in much the same manner. A four cylinder engine of the type of Fig. 60 has two pairs of cylinders as shown, bolted to a common base. In the three or four cylinder four cycle type such as is illustrated in Fig. 61 additional cylinders are added with the proper base.

The pistons and cranks may be arranged in a variety of ways. Fig. 62 shows the best arrangement for a two cylinder two cycle engine. The cranks are opposite, one piston ascending while the other is descending. Each thus balances the throw of the other. This arrangement also gives an impulse in each cylinder for each revolution.

Two cylinder four cycle engines may have the cranks arranged either as shown in Figs. 62 or 63, in the

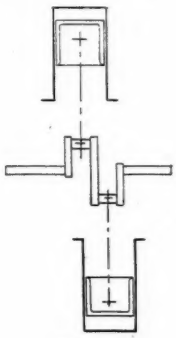


FIG. 64

former the pistons are balanced, but the impulses occur irregularly two occurring on adjacent strokes, with an interval of one revolution before the next two. In the latter, Fig. 63, both pistons move together; this arrangement so distributes the impulses that they

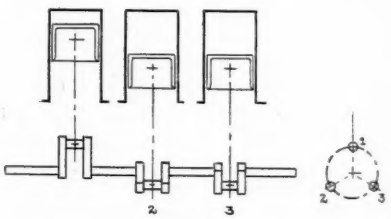


FIG. 65

occur regularly, one during each revolution. This arrangement, however, requires heavy counterbalances on the opposite ends of the crank, to balance the weight of the pistons; and it is likely, under certain

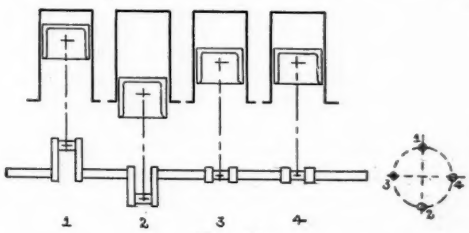


FIG. 66

conditions to cause considerable vibration. Both arrangements are used, however, in representative engines.

The arrangement shown in Fig. 64, or "opposed" motor has some advantages. It is almost absolutely balanced as the parts are moving either towards or away from each other and thus absorb the throw.

In the two cycle motor of this type the impulses occur together and on each revolution. In the four cycle they occur regularly and one for each revolution. This arrangement has some advantages, as it lies very low in the boat and may even be placed under a transverse seat. For auxiliary work it may be placed under the standing room floor.

In the cylinder engines of either two or four cycle types the cranks are almost always arranged as in Fig. 65—or 120° apart. This arrangement gives a good mechanical balance. The two cycle engine thus has three impulses for each turn and the four cycle has three for each two turns, they occur regularly, and are so timed that one cylinder is receiving its impulse while another is compressing, which is conducive to steady running.

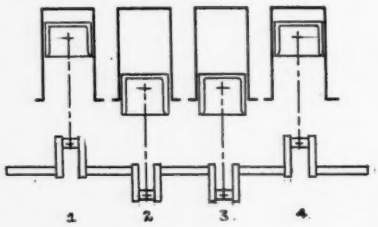


FIG. 67

Although for automobile work the three cylinder—four cycle engine has been discarded it is still popular and satisfactory for marine work. Four cyclinder engines of the two cycle type are very commonly arranged as in Fig. 66. The cranks are arranged in pairs, the two cranks of each pair being opposite each other, and the planes of the two pairs being at right angles. This makes the engine well balanced, each pair being balanced in itself. It also gives an even turning effort with four impulses per revolution, occurring regularly.

Four cycle four cylinder motors are probably best arranged as in Fig. 67, the cranks being all in one plane. The positions of Nos. 3 and 4 may, however, be reversed, bringing 1 and 3 up and 2 and 4 down. The former is, however, considered to be the better. Either arrangement may be made to give regularly occupying impulses, four during each two revolutions.

For high powers a larger number of cylinders are used—six or eight. A six cylinder engine would consist of two units like Fig. 65 coupled together and an eight cylinder, two like either Figs. 66 or 67 coupled together.

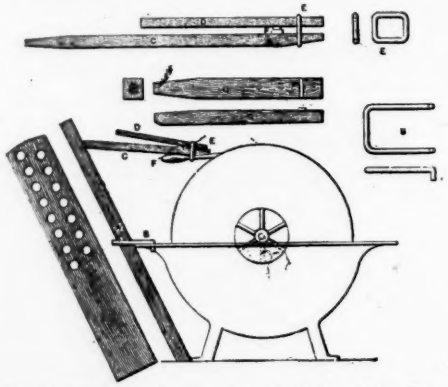
The advantages of multiple cylinder engines are becoming better appreciated and their use is increasing, even in small sizes; the exception being in working and fishing boats and other cases where cost is a prime consideration.

GRINDSTONE TOOL HOLDER.

GEORGE A. SEATON.

In many shops there are numerous chisels, cutters and plane bits that must be ground from time to time and if they all must be held by hand the process not only requires much skill but becomes very tedious long before it is completed. If a clamp is installed like the one here described the work is hastened, the results are better, and the job now can be entrusted to a boy.

First a board must be fashioned similar to A, two inches thick, six inches wide and long enough to come slightly higher than the top of the stone when attached as shown in engraving. The lower end of this must be beveled so that it rests flat on the floor when in position. The board is held in position by a hook forged of a light rod of iron with the ends passing down



through the holes in the trough that originally were intended for attaching the name-plate. In this board, A, must be bored a number of holes in such a direction that they are about parallel to the floor. These afford a number of resting places for the clamp proper, C D.

The clamp is made up of two pieces of inch stock as wide as the widest plane bit and with one end of C rounded to fit the holes in A. Upon strip C is fastened a little rib, F, which serves as a fulcrum for the piece D. At the end of D is fastened by staples an iron rectangle E made of welded strap iron which holds the chisel or plane bit against the lower side of C when the hand is passed down upon the other end of D.

By moving the chisel forward or backward in the clamp or by raising or lowering the rear end of C, any angle desired may be secured upon the chisel as it is pushed back and forth across the stone. By the use of this clamp the speed of grinding can be much increased as all the weight may be thrown upon the chisel edge and no thought need be given to the angle. The device illustrated is in use upon a Keystone grindstone but could easily be modified for any other stone.—"Wood Craft."

TRANSPARENCIES.

J. GARFIELD GIBSON.

When the ground is covered with Kipling's "Beautiful" to the depth of several inches and the chilling north winds remind us that straw hats and shirt waists are no longer seasonable, the average amateur folds his tripod, pokes his head under his focusing cloth and as far as photography is concerned calmly awaits the coming of another spring.

It is to this class of photographers that I hope, as the country orator says, "my few scattered remarks" will prove beneficial.

Many of the greatest pleasures of photography are those which can be experienced in the dark-room during the long winter evenings. Of the many novelties which can be made by the amateur there is nothing more beautiful than the natural color and tinted transparencies which we often see hanging in windows suspended by chains. These are very easily made, as I hope the following article will clearly demonstrate.

First it is wise as a start to choose what you would call a good negative: That is one which has been timed about right and developed to about the correct density. The plates upon which the transparencies are made need not of necessity be other than the ordinary plates used in general work. Special plates are, however, made for this work with a border of ground glass around the edge and are of course preferable.

Before printing be sure and dust off both negative and plate very carefully. As regards exposure—this will have to be learned by experience and much depends on speed of plate, density of negative and light used for making exposure. But an ordinary plate with an average negative held about 18 inches from a gas jet requires from one to six seconds. The exposure being made, the plate can be developed at once or kept in a tight box until some future time.

For developing we have as wide a choice as for ordinary work but I have found hydrochinon to give the best results and the following formula works equally well for either transparencies or lantern slides:

No. I.

Sulphite Soda (crystals), 400 grains. Dissolve, filter and add water to make 6 ounces.

Hydrochinon .....120 grains.

No. II.

Carbonate of Potassium .....240 grains.

Water to make ..... 6 ounces.

For use take 1 oz. each of Nos. 1 and 2 and add two ounces of water. This water may be decreased or increased as may seem fit. Development should be carried on until the picture comes out clear and distinct.

The fixer for transparencies should be a little weaker than for ordinary plates. After fixing wash and dry as usual.

If you are using regular transparency plates your task is now completed, otherwise you must back it with a piece of ground glass, same size.

You can now bind your finished article in one of the metal frames supplied by all dealers or hang it by chains, doubling the chains at the corners.

Many beautiful effects may be obtained by coloring the transparencies and I give below some formulas for so doing.

Having proceeded as described above immerse plate in any of the following baths until desired tint is obtained.

Red Bath.

Carmine (in grains)	5 parts.
Liquid Ammonia	15 parts.
Distilled water 120	parts.

Blue Bath.

Prussian Blue	50 parts.
Oxalic Acid	50 parts.
Distilled water 120	parts.

Yellow Bath.

Gamboge	50 parts.
Saffron	50 parts.
Distilled water 150	parts.

(Above yellow bath must boil five minutes and then be filtered.)

After being treated in any of the above, plates should be washed in several changes of water and be dried free from dust.—"Western Camera Notes."

A new process of making quartz-glass in much larger quantities than has hitherto been posible has been discovered by the employment of high temperatures and pressures. In a quartz-glass vessel, gold, copper, or silver may be melted or even vaporized without injuring the receptacle. Quartz-glass expands scarcely at all; hence cold water will not break it, if poured over it even while hot. It transmits freely the ultra-violet rays of light, to which ordinary glass is almost opaque.

The discoveries connected with radio-activity have enormously increased the estimated stores of energy surrounding us, but these stores have not yet yielded up mechanical effect for the use of man, if we except the radium clock.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

88 Broad St., Room 522, Boston, Mass.

A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

Subscription rates for the United States, Canada, Mexico, Cuba, Porto Rico, $1.00 per year.

Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

New advertisements or changes, intended for a particular issue, must be received at this office on or before the 10th. of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

FEBRUARY, 1907.

The prize offer in the December number produced such a large number of articles that the judges have been able to make only the awards for the first two prizes, as follows:

First prize, Elmer C. Hutchinson, Philadelphia, Pa.

Second prize, H. K. Carruthers, Otawa, Ont.

The third prize will be announced in the next number. The article by Mr. Hutchinson, "A Combined Circular Saw and Boring Machine," was published in the January number. The one by Mr. Carruthers, "A Water Motor," will appear in the March number. Other interesting articles received in this competition will be published in early issues.

Owing to the very successful results from this plan of obtaining articles of interest, we are now arranging for similar competitions, but shall allow a longer time for preparation, as several competitors have advised us that the previous offer did not allow enough time to enable the writers to prepare articles requiring considerable drawing and taking off of dimensions, and that some of the articles sent in could not have been finished in time, had they not been in preparation before the offer. In anticipation of subsequent offers, readers having any machine or device which they think would be likely to be of interest, will find it advisable to get the descriptions and drawings in hand, so that when an offer is made the preparation of an article can be given the necessary attention so that it will be complete in both a literary and mechanical way.

It is not customary for us to refer to our advertisements in this column, but owing to the character of the one received from the General Electric Co., West Lynn, Mass., and its importance to many of the younger readers of this magazine, we do so for the purpose of emphasizing the exceptional opportunity offered to young men desiring to learn a trade. A personal visit by the editor of this magazine to the works of this company, shows that the company have provided a most complete equipment of tools, and well selected class of work for those entering their employ. In addition, a school is maintained, with regular instruction periods, the instruction being given by practical mechanics who have shown special fitness for that work. Especially noticeable was the intelligent and gentlemanly character of the young men at work, ensuring proper and agreeable companionship to anyone joining their ranks. Our purpose in mentioning this matter in this was is that those at a distance, who have not the opportunity of personal investigation, may rest assured that everything connected with the learning of a trade will be found entirely satisfactory. We hope to publish in an early issue a full illustrated description of the system, which we are sure will interest a large number of our readers. Those who have the matter of learning a trade under consideration, but have hesitated because of lack of knowledge of a suitable place, should obtain further information by applying to the company.

Our supply of complete sets of bound volumes is being rapidly sold. If you want a set order at once, or you may be unable to get them.

Anyone scanning the Official Gazette of the United States Patent Office will find much interesting information, which is not quite submerged beneath queer spelling and rudimentary grammar, says the "Mining Press." This record of the inventive minds of the country is eloquent of the multifarious channels into which its energies are directed. Apparently drinking is an important function of our people, for the non-refillable bottle is the elusive goal of so many ingenious people and next to it comes its complement the bottle-stopper. The importance of railroad operations is reflected on the pages of the Gazette, for nut-locks, automatic switches, car-couplings, and signaling apparatus are invented every month. The farmer is in the mind of the inventors who take out patents for disc-harrows and self-closing gates. While the art of printing and the multiplication of writings has progressed rapidly, there is hope of further advance, for printing devices and typewriting machines are commonly found among the new patents. Toys bespeak a love for the little ones and it is satisfactory to observe that the amusement of children should be regarded as a profitable business. Finally, the childlike in man is expressed in the many garment supporters, clothes-presses, and hat-hangers which are designed each month. It argues at least a regard for neatness, to which cleanliness is allied, and a growth of taste in one of the small, but salient features, of the manner of living usually termed civilization.

A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

IV. Finishing Frame and Deck Beams.

The boat is now clear on the inside and all plank fastenings have been done. The entire inside would best be treated to a good coat of linseed oil and painted, to prevent its shrinking during the remainder of the work. The inside work may now be put in, beginning with the clamp, shown in Fig. 23 and in the enlarged Fig. 20. This clamp is 2 1/4 in. x 2 1/4 in. of spruce; it fits into the angle between the frames and deck beams and supports the latter.

The frames are cut off square at the level of the top of the top streak. The clamp is now bent around on the inside of the frames 1 1/2 in. in below the edge of the top streak and held in place by clamps until it is carefully adjusted. It may then be fastened into place with 1/4 in. galvanized iron rivets passing through plank, frame, and clamp, and headed over on the inside. The clamp should be in one length for each side and extend from the inside of the stem to the stern board.

Knees are fitted at the ends as shown in Fig. 21, a corner keen at the after end and curved breasthook at the bow. For the bow knee or breasthook a piece of a natural growth knee will be required. It is shaped as shown in order to fill the open space between the clamp and the plank and give a good fastening for the latter. If it is impossible to obtain the clamps in one piece the joint should be made about amidships, and a scarf piece about two feet long, fitted on the inside, as shown in Fig. 24, and through riveted.

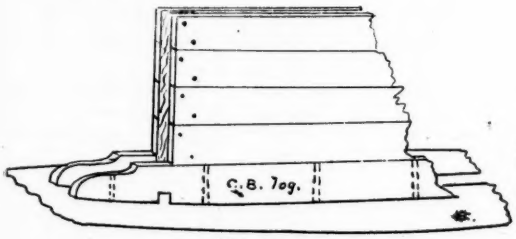


FIG. 19.

A bilge stringer must be fitted on the inside of the frames just below the turn of the bilge as shown at b' Fig. 23. It is 5 in. wide and 3/4 in. thick and should run the full length in one piece. It may be tapered in width to 4 in. at the ends if desired. It can be bent without steaming and fastened with nails into each frame. Hard pine is very good material for these bilge stringers, as it is strong and comes in good lengths although cypress or even spruce may be used.

The deck beams may now be gotten out. They are cut from stock 1 1/2 in. thick and are 1 3/4 in. deep. They are curved in such an arc that the "crown" or curvature is 3 1/2 in. in 8 feet; or in other words, if the beam is rested upon the floor its middle point will be 3 1/2 in. above the floor; four of these beams should be of oak and the remainder of spruce. These deck beams can best be cut out at a mill where a band saw is availible. They may then be smoothed up by hand.. For the half beams alongside the standing room and cabin straight pieces are used 1 3/4 in. deep and 1 in. wide. Fig. 20 shows the method of fitting the beams. They are placed just aft of each frame. The top surface of the clamp is about level, while the under surface of the deck beam slopes, so that a notch is cut into the clamp at the right angle to fit the slope of the beam and deep enough to bring its upper surface even with the top of the top streak.

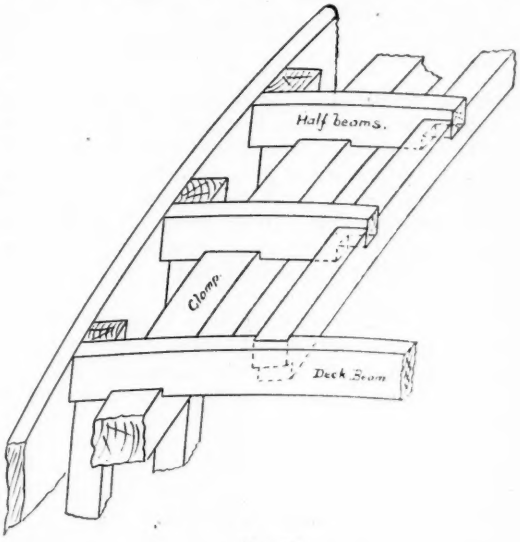


FIG. 20.

The first beams to be fitted should be those at the forward and after ends of the cabin house and at the after end of the standing room. The oak beams are used for this purpose. These beams are placed at No. 2 mould, one frame aft of No. 4 mould, and at No. 7 respectively. Before cutting off the beams measurements should be taken to make sure that the widths of the hull are correct and that it has not

changed shape. When the proper width is assured the beams may be cut off and fastened in place as before described. They are held into place by 1/4-in. rivets driven through beam and clamp. The remaining oak beam is now put in on the next frame forward of No. 2 mould, these two forward beams forming the mast partners. These four beams are the main stiffeners of the deck frame and must be well secured in place. The beams forward of the cabin and aft of the standing room may then be fitted, using the spruce beams. Each beam, as already mentioned, is placed just aft of each frame, being neatly let down into the clamp and fastened with a rivet. If desired as an additional fastening a galvanized nail

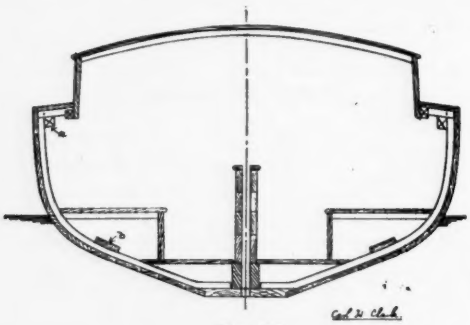


FIG. 23.

may be driven diagonally through the end of the beam into the frame, but this is not wholly necessary.

The half beams are next gotten out; they are 1 in. thick, 1 3/4 in. deep and 8 in. long. They are notched down into the clamp in the same manner as the others. Their inner ends will be supported by the sill, as shown in Figs. 20 and 21. The ends of the beams are notched up 3/4 in. and 1 3/4 back, to fit a corresponding notch in the sill.

The sill is in two lengths on each side, one length extending the length of the cabin trunk and the other the length of the standing room. The sills are let into the heavy beams at the ends and have notches at the proper places to take the ends of the half beams. The notches for the half beams are cut 3/4 in. deep and I in. wide; this brings the top of the sill about 1/4 in. below the tops of the heavy beams. The notches in the heavy beams are so cut that the inner edge of the sill is 9 in. from the outside of the plank and parallel to it. Sill and half beams are now fastened in place, taking care that all beams are fair and that the sill is parallel to the outside of the plank. The sills are fastened to the half beams and to the heavy beams by galvanized nails driven diagonally. The rounding corner pieces, as shown in Fig. 21, are 1 1/4 in. thick, and are fitted into the corner between the sill and the beam as a support for the curve.

The top of the stem is now cut down, leaving only the tenon as shown, about 1 in wide. The upper edge of the stem board is also trimmed off to the same line as the deck beams, so that the deck plank will be evenly across. The edge of the top streak is bevelled slightly to conform to that of the deck.

At the masts and bitt-post oak blocks are fitted between the beams and fastened through. They are 1 1/2 in. thick and about 1 1/2 feet long, with the grain running as shown. They must fit neatly under the deck and it will be necessary to plane them off somewhat rounding on the upper face to accomplish this.

The boat is now ready for the deck, which should be of fairly clear pine, 3/4 in. thick; the middle plank of the deck may, if desired, be of oak about 10 in. wide. In this case the middle plank should be laid first, taking great care that it is exactly in the middle; a line stretched from stem to stern will help in this. The other planks should then be put on about 6 in. wide, straight fore and aft. The edges of the plank should be tongued and grooved, as this makes a very tight and neat deck, which does not re-

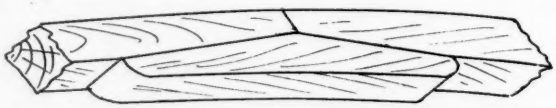


FIG. 24.

quire calking. At the edge of the deck a very wide board should be used, as in Fig. 21, at least 15 in. wide being desirable, as the curve of both cabin and gunwale are cut from it. The deck planks are nailed to each beam and to the edge of the top streak, 2-in. nails being used and the heads being "set" slightly below the surface. All joints and the under side of the deck planks should be painted before putting together. The edges of the deck plank may now be trimmed down even with the side plank on the outside, and on the inside just even with the sill and curved corner pieces.

The cabin trunk is next to be worked in; it may be of either pine or oak. It will be in two pieces joined at the forward end, each piece being about 9 ft. lang, 14 in. wide and 3/4 in. thick. A template should be made from 1/4-in. stock, by bending it around in place and laying out the outline on it. The trunk is 11 in. high at the after end, 7 1/2 in. high at the point where the curve begins at the forward end, and about 6 in. high in the middle. Having these points, the curve of the top edge can be drawn, and also the curve of the lower edge. The template is now taken down and the outline cut out. The two boards are then cut out to fit the template. The bending and fitting of these trunk sides is perhaps the most difficult part of the entire construction, on account of the width of the boards and the sharp bends, with

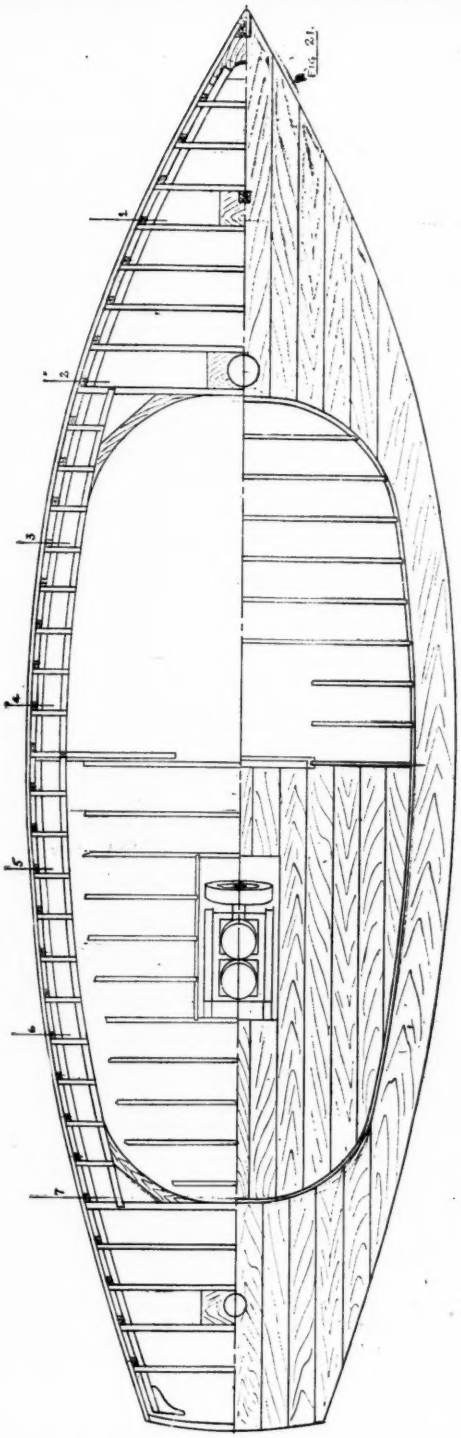


Fig. 21.

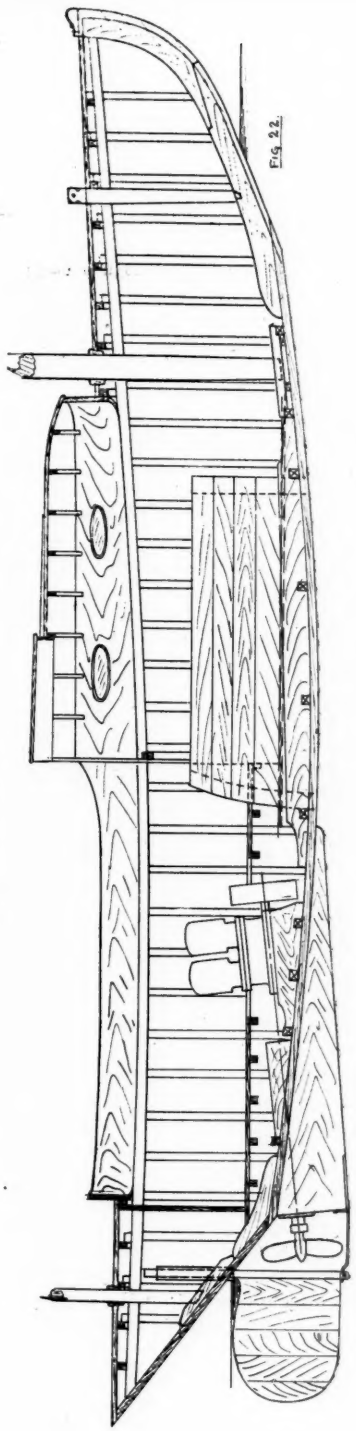


Fig. 22.

the consequent tendency to split. They must be bent one at a time and thorougly steamed on the end which is to be bent. A rough form should be made of about the same curvature as the end of the house. When the board is sufficiently limber it is bent around the form and fastened in place to cool. More curve should be given to it than is necessary, as this makes it easier to force it into place. When it has cooled and "set" it may be set into the boat and drawn up into place by clamps. This operation is apt to split it if great care is not used; it may, however, be prevented by placing a block under each clamp to distribute the pressure. The trunk is fastened in place by screws driven through it into sills, corner pieces and beam, drawing it up tightly into place. The sides of the trunk should not be exactly vertical, but should slope inward slightly. The forward ends of the two parts of the trunk should be allowed to overlap, while fitting and fastening them in place. Both may then be cut off together to exactly fit end to end. A block of the same width and thickness is fastened on the inside to cover the joint. A brace should be fastened across the top at the end of the trunk to prevent the sides springing out.

The coaming around the standing room is of oak 5/8 in. thick, standing 6 in. above the deck at the side. The method of fitting it is the same as for the trunk, but much easier, as it is narrower. Where it joins the trunk side it is trimmed down to 1/4 in. and let into the latter to make a smooth joint. A butt joint is made between the two portions, at the after end, in the same manner as the trunk sides.

The trunk should be painted inside and out, but the standing room coaming should be left bright and finally shellaced.

AFRICAN VANILLA CULTURE.

Consul-General Richard Guenther, of Frankfort quotes from the exhaustive report of Richard Gomolla in the "Tropenpflanzer" the following summary as to the cultivation and preparation of vanilla in German East Africa:

The best variety of vanilla comes from vanilla planifolia, which requires a mucky, porous soil. The plant thrives up to a height of about 1600 feet above sea level and as its fleshy roots do not penetrate deep into the soil it requires only a proportionately thin layer of soil. The plant bears merchantable fruit in the third year, sometimes even in the second year, which require from seven to eight months to mature, and the harvest takes place from April to June. Five to seven harvests are made from the same plant before it is exhausted. New plants must not be planted in the same place as the old.

Protection against wind, also shade, is of great importance for the growth of the plant, and therefore the fields must be surrounded by trees and hedges. Grubs and snails are enemies of the vanilla plant; the former eat the roots, the latter the young sprouts and beans. While in the third year only about one-tenth part of the plants blossom, the percentage increases from year to year up to the seventh. The cultivation of vanilla in German East Africa is impeded by the absence of insects which are instrumental in fructifying the vanilla blossoms. Each separate flower has therefore to be fructified by human hands, the cover of the stigma being raised by means of a thin little rod and the pillen, which is just above the cover, is pressed against the stigma.

When the young beans have grown to the length of a finger, they must be closely inspected and all defective ones must be cut off. The beans mature from seven to eight months after the fructification process. The ripe beans have a yellowish green color.

The way of preparing the beans varies, but an ever-increasing temperature is required to dry them and obtain the well-known brown-black color. In this way, the thin-skinned bean with its fine aroma is produced. If hot water is used for heating the beans, they are placed in baskets and immersed in it. The water has a temperature of 80° to 84° R. Afterwards the beans are packed into wooden boxes, which are lined with woolen cloth, and closed. The next day they must have a glassy appearance. They are then again wrapped in dark woolen covers and laid in the sun to dry. If the weather is rainy, they must be dried in a dry-room at a temperature of 50° R, but an after drying in an airy room of from two to four weeks is necessary. After that the dry beans are packed in tin boxes, where they, however, require close inspection, and have to be repacked every week in order to remove diseased beans or such which have become moldy.

The value of the beans is measured by their length, which is from 12 to 25 centimeters. For shipment they are sorted, bound in bundles, and put into tight but not soldered tin boxes, which are now lined with paper instead of tinfoil, as formerly. Black mould is especially dangerous to the beans, while white mould is rather harmless.

In the bulbs of incandescent lamps it is noted that the incandescence is no longer produced if the proportion of oxide of cerium added to the oxide of thorium is less than 1 per cent. The incandescence is due to an oscillatory oxidation—that is to say, one that is alternately produced and extinguished. When oxidated the cerium might combine with thorium, when there would soon be decomposition, then reoxidation and combination, and so on. These reactions, produced millions of times a second, occasion the luminous oscillations of the ether which produce incandescence.

Renew your subscription before you forget it.

ATTACHMENTS FOR SPEED LATHE.

C. TOBYANSEN.

The ambitious carpenter who has a small private workshop should by all means include a turning lathe among his possessions. It will pay for itself, if only in the time saved by an emery wheel attachment for grinding tools. The initial cost need only be a head and tail stock. The rest, such as lathe bed or ways and flywheel, tool rest, etc., can be largely made by the carpenter himself.

Most every user of tools, be he an amateur or practical mechanic, likes to manufacture articles useful or ornamental for his home and fireside; often, also, small fancy products suitable for presents wherewith to endow friends and relatives on festive occasions, thereby saving heavy drains on his purse. And articles so made and given have a far greater valuation than a purchased present equally costly, because of the closer personal associations a home-made article brings with it, bearing more or less the stamp of the individual ingenuity, skill and taste of the maker.

Turning enters largely into the manufacture of such products, as also into the making of household furniture of all kinds. But it is not in the sense of turning only that the lathe can be made useful. By simple home-made attachments one may perform most any of the mill operations, so-called, on a small but effective scale. A fret or jig saw is a much needed complement in all kinds of woodworking operations. Such an attachment is shown in Fig. 1 of the illustrations, where A A represents the lathe bed or ways and B the back table. Upon this rests the jig saw, which may be fastened by screws into the ways. The attachment is made entirely of wood, as shown. The frame proper consists of the two arms D D and the pack piece E, shown in dotted lines, and on which the two arms are rigidly fastened. This frame carries the saw blade at F F and swings on the pivot at G, which is an iron bolt, passing through from side to side. As will be understood from the sketch the frame is incased between the pieces and swings freely up and down, still not so loosely as not to be properly guided. The pivot should be in the line with the top of the saw table K. The piece L is adapted to slide back and forward in order to give freer access to the lower arm for adjusting saw blade. The rod M is stationary between the sides of the case H, and is a guide for steadying the blade in the cut. It is fitted with a small, round, hardwood piece slotted to receive the blade. This hardwood piece has to be renewed from time to time as it wears, and is merely struck into a hole bored in the end of the rod for this purpose. The saw blade should be of such

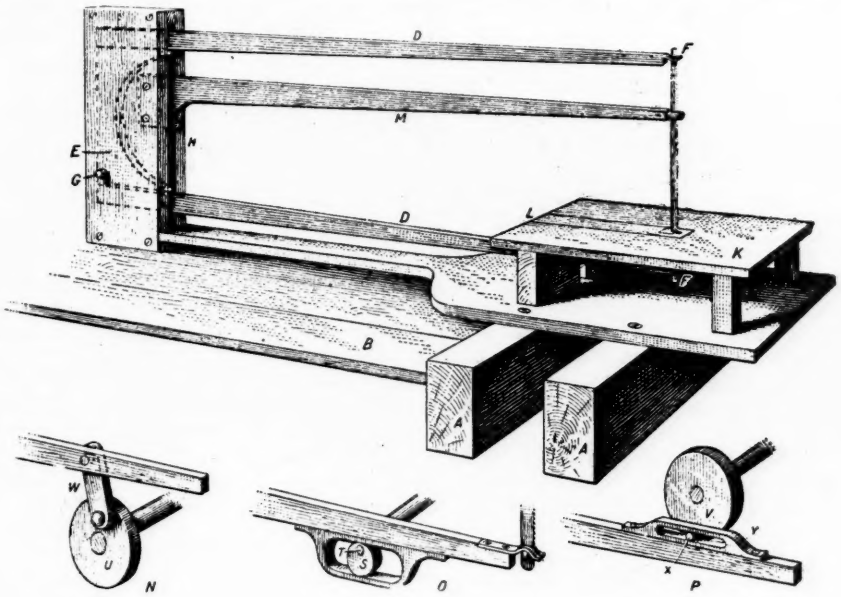


FIG. 1.

length as to slightly force the arms D together, thus keeping the blade taut and stiff. The arms have at the ends a small brass plate fastened on with screws projecting about 1/2 in. beyond the wood and slotted to receive the blade. This is more plainly shown in the sketch O on the same figure, which shows the end of the lower arm. As will be seen the brass plate mentioned has a slight curvature upward. On the upper arm this curvature is downward. The saw is fastened by means of a brad passed through a hole drilled in the end of blade for this purpose. In order to drill this hole without breaking the blade it is advisable to draw the temper at its ends. If the blade is a very fine one a thin wire may be wound about the ends serving the same purpose, or the end may be slightly upset by placing the blade in a vise and hammer lightly on the extreme end, thus raising a burr thick enough to prevent the saw slipping through the brass jaws. The slide L in the saw blade may also be fitted with a sloted brass plate to receive the back of the saw blade, thereby giving a steadier vertical motion. This is rather necessary if the saw frame has worn slack in the case.

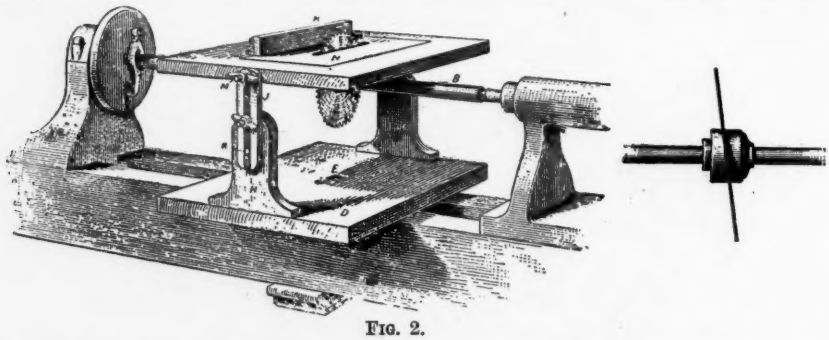


FIG. 2.

At N, O and P are shown three different devices for transforming the rotary motion of the lathe into the reciprocal motion of the saw. The small eccentric S in the sketch O is operated by the shoulder T reaching between the centers of the lathe. This form is more especially adapted to a lathe run by steam power. This journal should be made as long as needed to give sufficient swinging room for the work, and may be further steadied by passing through blocks or rest on each side of the saw tablt, close fitting enough to prevent vibration, but still not tight enough to cause friction. Lampblack will be found an excellent lubricant to prevent the latter.

The devices shown at N and P are both adapted to operate directly from the face plate of the lathe, U and V representing face plates. In sketch N the connection with the saw bar is made by the driving rod W, which is bolted loosely to both. At P the peg X is fastened firmly to the face plate and extends through the slide Y, fastened to the saw bar. These two latter devices are equally adapted to a foot-power lathe. The saw table should be high enough to allow the lathe head to pass entirely under it, bringing the face plate close up to the saw bar.

In Fig. 2 is shown a circular saw attachment, the need of which is too important to the woodworker to need comment. The saw blade is mounted on a steel arbor, which can be purchased of any machine dealer. The saw blade in the sketch need not exceed 8 in. in diameter and should be of light gauge. The arbor B is hung between two pointed centers and a dog connects it with the slotted face plate, thus complying with the motion of the lathe. The bed table D is fastened to the lathe bed by the bolt F, which reaches down to the plate F underneath the bed. A wedge driven between this and the lathe bed will fasten the saw stand firmly. This same device may be used equally well for the jig saw. The brackets H H are fastened firmly to the bed table. The slotted piece J, which connects the bed, table and the saw table proper, is guided by the peg K and fastened by a wing nut. The table can thus be raised or lowered at will, admitting of any desirable depth of saw cut. It is further adjustable by the wing nut M, which adapts the table for bevel cutting. The piece N, inserted loosely in the saw table, is beveled in the slot on the underside to admit clearance for the saw in bevel cuts.

By placing a beveled collar on each side of the saw blade, as shown at the right in Fig. 2, the saw may be placed out of line and can be adjusted according to the bevel given the collars, which are made of wood. This is a useful arrangement, for many purposes where a wide cut is desirable, such as plowing, rabbeting, notching out for dentals, and the like. When such a saw is used the piece N must be replaced by one having a wider slot. The guide R must also be removed and replaced with a cross cuting guide adapted to cross the table and slide against the saw, the construction of which may be safely left to the reader's ingenuity. By the way, the bevel saw arrangement mentioned above is commonly called "a wabble saw."

An emery wheel can also be fastened on a saw mandrel. But it would be advisable to procure a sec-

ond mandrel, so as to prevent too much changing about. A cheaper way is simply to turn a hardwood spindle to fit the hole in an emery wheel, so it will drive fast on the spindle, and we have our grindstone complete.

In Fig. 3, is shown an easy method whereby the edges of the work in hand may be molded in simple designs. A shows a sectional view of a center chuck, which generally is included among the fixtures when

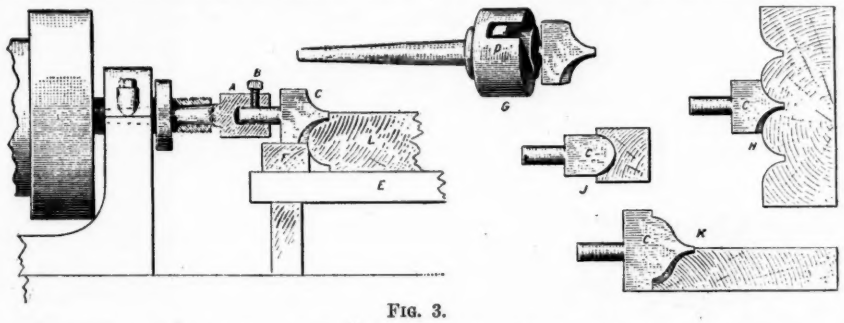


FIG. 3.

a lathe is purchased. It fits into the spindle of the headstock as an ordinary center, and is meant to carry boring bits by inserting them in the hole and fastening by set screw B. In this case a cutter is inserted, as C, while E is a false table resting on lathe bed, built up to suitable height, F being a strip of wood serving as a guide for the piece L, which is being molded.

It will be understood that the molding surface is limited to one-half of the cutter. It is desirable, however, to grind both halves alike in order that both may cut. It makes better work and is easier and steadier to operate. The cutters can be made out of old files ground to shape on the emery wheel and touched up by filing where needed. The temper must be drawn first in order to file, and they can be retemperd if desired for hardwood cuting. In order to form the full bead on the edge of piece L it has to be reversed—that is to say, one-half cut from each side running it steadily against the guide F. By raising or lowering the table several beads may be formed with the same cutter, as indicated at H in the drawing, C showing the cuter blank.

Fluting may also be done with a half round cutter, as at J. An ogee mold is shown at K suitable for table tops, giving a pleasing finish.

The head of set screw, like the one shown at B, projecting as it does is a dangerous affair and the cause of many injured fingers and hands, hence the ounce of protection shown at G in the form of the ring D. It is simply a hardwood ring fitted properly over the center chuck, thick enough to come flush with the bolt head and having an opening cut for the same large enough to admit of turning it around with a socket wrench.

SEAWEED IN NORWAY,

Seaweed burning in Norway produces an annual income of £30,000. Along the shores of Joderen, on the southwest coast of Norway, the seaweed grows in veritable forests. This is not the common grass variety, but actual trees from 5 ft. to 6 ft. in height, with stems like ropes and leaves as tough as leather. It begins to sprout in March and April, and gradually covers the ocean bed with a dense impenetrable brush. In the fall the stems become tender, the roots release their suction-like grip on the rocky bottom, and the autumn winds wash it ashore in such great quantities that it looks like a huge brown wall along the entire coast. The fall crop is of comparative small value. The only use that can be made of it is for fertilising purposes, because it is only in the spring that it can be successfully burned, and at this time there is such a demand for it that every stalk and leaf is gathered. The weed-burning season is the busiest of the year, and every member of the household is drafted to assist in gathering, drying and burning. At the close of each clear day the whole coast seems to be aflame from thousands of bonfires that are kept burning far into the night. Owners of farms located where the weed seems to have a predilection to drift produce as much as 3000 lb. of ashes a year, which sells for from $1.75 to $3.75 a pound.

Generally speaking, electric furnaces may be divided under two main headings—namely: those in which the heating effect is produced by the electric arc established between two carbon or other electrodes connected with the source of current, commonly known as arc furnaces; and those in which the heating effect is produced by the passage of the current through a resistance, which either forms part of the furnace proper, or is constituted, by a suitable conducting train, of material to be treated in the furnace. The principle of the later type is analogous to that involved in the heating to incandescence of the ordinary electric lamp filament, and such furnaces, are as a class, known as resistance furnaces.

Have you sent for a premium list?

HOW TO MAKE A MICROTOME.

J. E. PAYNTER.

A microtome is an appliance used for cutting very thin sections of the stems, leaves, etc., of plants, for examination under the microscope. One of the most common methods adopted by those who do not passess a microtome is to hold the stem or other object between two pieces of pith or potato, and then take off very fine parings of the potato, and, at the same time, of the object embedded therein, with a razor. This is not an ideal method, as it is difficult to obtain very thin sections; there is also an element of danger in the operation, seeing that the razor used for cutting has to be very sharp.

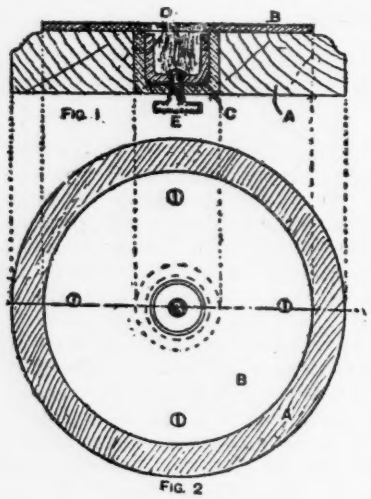


FIG. 2

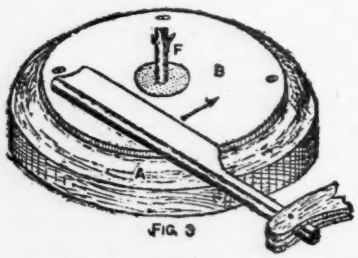


FIG. 3

Some mechanical aid, therefore, is necessary if really satisfactory work is to be produced. There are many expensive and elaborate patterns of microtomes made for this purpose, but the one to be described will serve very well for all ordinary requirements, and can be put together at a very slight cost. Those who desire to make them for profit would have no difficulty in selling them at a remunerative price among botany and biology students.

Figs. 1 and 2 are section and plan respectively of the appliance, Fig. 3 showing the method of using it. The first thing needed is a circular disc of wood A, from 4 in. to 5 in. in diameter and 3/4 in. thick. A gas block, such as is used for fixing gas brackets to walls, suits the purpose admirably, and will be ready turned to shape, moulded on the edge, and polished. In the centre of this block bore a hole, 1 in. bare in diameter, entirely through the thickness. Next cut a circular piece B, of thin brass or zinc, to the same diameter as the top of the wooded block. Before screwing this plate to the block, drill a 5/8 in. hole in the centre of it, taking care to make it centre correctly with the hole in the block. Then file off the top surface of the plate, and smooth it with emery and oil.

Now procure a blank cap C (Fig. 1)—that is, a piece of brass pipe with one closed end—of 1 in. external diameter, and file it off so as to make the length equal to the thickness of the wooden base. A hole is drilled through the closed end of the blank cap, tapped to suit the thread of a milled-head screw E, which should be about 3/16 in. in diameter. Cut the screw off, if necessary, to about 3/4 in. long, measured from under the milled head, and, by filing, or by turning it down in the lathe, form a step 1/32 in. deep and 1/4 in. from the end. This end of the screw is to pass through an inner cylinder D, as shown in Fig. 1, and after being inserted must be riveted over to prevent its withdrawal. The inside cylinder, for which another brass blank cap may be used, must be made to fit closely into the outside cap C, but with just enough play to allow it to work easily up and down. The inner cylinder D is cut so as to be 1/16 in. below the under side of the surface plate B—that is, 1/2 in. or 9/16 in. long (see Fig. 1).

When these various pieces have been fitted neatly together, the external cylinder C, with its fitings, is driven tightly into the 1 in. hole previously bored in the wooden base, until it comes up tight underneath the surface plate. The microtome is now ready for use. When the milled-head screw is turned, the inner cylinder will be raised or lowered within a limit of 1/16 in. the underneath side of the surface plate preventing it from raising farther.

Now a word as to the method of using the microtome. Suppose it is desired to make a very thin cross section of the stem of a plant. First melt together some white wax and olive oil, so as to form a solid block when cool. A small quantity can then be used as required. Take a little of this prepared wax, melt it, and, having turned the milled-head screw so as to lower the inner cup as far as it will go, pour the molten wax through the hole in the surface plate into the cup

until the wax reaches the level of the surface plate; then, while the wax is still liquid, stand the plant-stem F (Fig. 3) upright in the middle, as shown. Allow the wax to cool, and then turn the milled-head screw about a quarter of a revolution, so as to raise the inner cup very slightly, and with it the wax and the embedded stem.

Now take an old razor, and grind one of its faces perfectly flat, and sharpen it up from one side only as if it were a chisel. Press the flat side of the razor in close contact with the metal plate, and push it forward, slicing off the top of the wax, and paring the stem level with the face of the plate. Then turn the milled-head screw very carefully for another quarter revolution, or less, so as to raise the inner cup and wax very slightly higher. Repeat the work with the razor, when it will be possible to pare off an extremely thin slice of wax, with a very thin section of stem embedded in the centre. Do not attempt to handle the delicate section with the fingers, but float it off the razor with a camel-hair brush into a little alcohol, which will dissolve the wax. The section may then be strained, and mounted on an object-glass in the usual way. It may be necessary to add that as the milled-head screw projects below the microtome, a hole should be bored in the bench top sufficiently deep to take the projecting milled-head screw, thus serving the double purpose of allowing the microtome to rest firmly on the bench, and preventing it from sliding along the bench when the razor is being used.—"Work," London.

BRAZING.

E. A. SUVERKROP.

In spite of the fact that there are hundreds of brazed flanges on the average steam ship it is surprising how few engineers know anything at all about the job. This is no doubt due to the feeling among engineers in general of "every man to his own job." The ability to do a fair job of smith work is no doubt of great assistance to the engineer at times and why should he not be able to do a fair job of brazing? Brazing is considerably easier than smith work. I would undertake to make a good brazer of any intelligent man in from twenty minutes to an hour, but who could make a smith of a man in that time?

I will first take the general principles of brazing under consideration. Brazing is the joining together of two pieces of metal by means of another metal having a lower melting point. It is practically the same as soft soldering excepting that it is done at a higher temperature and the solder of spelter used is an alloy of copper, tin and zinc or copper and zinc instead of tin and lead. The joints to be brazed should be as nearly clean bright metal as the job permits. Grease and dirt are antagonists to a good job. The parts to be brazed should be securely held in relation to each other, either by pins put through them or by wiring to each other or by other means. The heat applied should also be clean. Hard coal fires are fairly good, a fire of soft coal charred is also good, but perhaps the best is a gas and air blast. Gasoline or oil blast also give good results.

In brazing a flux must be used. Formerly borax in one form or another was the only thing that would do. Some brazers used it powdered, some in crystals, some mixed it with water, some didn't. Some melted it in a crucible; it was then called "burnt" borax. It was then broken to various degrees of fineness according to the individual whim of the brazer, each one of whom would declare that his way of breaking the borax was the prime reason why he produced good work. The drawback about borax is that while it is a good flux it becomes as hard as glass after the job is cold. In this state it is difficult to remove and ruins the hardest file. A better flux than borax in any form is boris (also called boracic) acid. It comes in crystals or powder. I prefer the crystals for some work as the powdered form is apt to curl up and blow away while the crystals do not. Boric acid does not form a hard scale and if you know how to handle it does not leave any scale that cannot be almost rubbed off with the hand.

In jointing up ready for brazing the joints, one need not leave room for the brass to run in. They can be drive-fits, for if the heat and flux and spelter be applied in the right manner the brass will run into the tightest joint. The beginner, however, had better not fit his pieces too tight; just make them an easy drive fit, put one or more pins in to hold the pieces together.

We will assume that we have a steel flange to braze on a steel pipe. The flange has been bored or filed to fit on the end of the pipe which has also been filed or burned bright, the joint is clean, bright metal to metal. The job should be put in the fire so that the pieces are heated as evenly as possible. In this case we will assume (what is generally the case) that the flange is heavier than the pipe. It stands to reason that it will not heat as quickly as the pipe which is lighter, we therefore heat the flange first, placing it in the hottest part of the fire. While the heat is coming up the brazer applies the flux to the joint with a brazing "spoon." I generally make my brazing spoons out of a piece of 1/4 or 5/16 inch iron rod of suitable length,

say two feet, with the end heated and beaten out flat about 5/8 inch wide by 1 1/2 inches long. As the heat increases and the flange and pipe become a dull red the flux melts and runs all over the job, some of it runs into the joint where we want it but the bulk of it is lost. As it is cheap this does not signify. When the job reaches a so-called cherry red, that is to say, a heat at which one would temper a chisel, it is time to put a little spelter on as this heat is very near the melting point of the spelter. The spelter is applied with the spoon together with more flux and is guided into the top of the joint by the spoon. In a few moments the brazer will notice that the spelter has begun to flow and run about all over the joint almost the same as mercury. The heat is kept on a little longer, say a minute or so according to the size of the job, while more spelter and flux is applied. The job is then lifted from the fire, being handled carefully so as not to jar it, and while still red hot the flux is brushed off with a steel brush. This treatment applies especially when borax is used as it eliminates a good deal of hard work later. The job is then allowed to cool till it is at such a temperature (a dark red) that immersion in water will not harm it. It is then put into a saturated solution of sal soda water or strong soap water. When cool the scale is easily brushed off, leaving the steel and brass clean and bright.

The spelter to be used varies according to the material on which it is to be used. On steel any kind of brass can be used, as the melting point of any brass is below that of any steel. I have also brazed steel with copper when no brass was at hand.

For brass and copper a soft brass with a low melting point must be used and great care must be exercised in order to avoid melting the job itself, especially so if it is brass, as the chances are that there may not be much difference between the melting points of the job and the spelter.

It is often desirable to repair a piece of cast iron that has been broken. A great number of very good brazers assert that cast iron cannot be brazed, and an equally large number of people having some patent process or another assert that it can but only by their particular method. Both are wrong, cast iron can be brazed with common brass and common borax or boric acid. There is no mystery about it. The joint should be thoroughly clean, the pieces should be firmly pinned together so that they cannot alter their position with relation to each other, the heat should be applied slowly and steadily while plenty of flux and spelter are applied and the job should not be hurried in any way. Let the job stay in the fire for a long time, to use a blacksmith's phrase, "Let it soak in the fire." A braze made in this way will be just as good if not better than one made by any of the patented or secret (?) processes.—"The Marine Review."

SPONTANEOUS COMBUSTION.

A peculiar case of spontaneous combustion is described in Cassier's Magazine by S. E. Wowell, who says that on February 17, 1906, two large refrigerator cars of young rose bushes were received at Hannibal, Missouri, from a nursery in California, for cold storage and general distribution throughout the surrounding country. They were shipped in wooden cases containing numerous auger holes for ventilation, and they were carefully packed with wet sphagnum, or California swamp moss, to prevent chafing and to support their vitality. No ice was put in the cooling tanks, and the covers of these, as well as all other openings in the cars, were closed as tightly as possible. The cars were ten days in transit. The outside temperature was 60° F. at the start, and 158 at the end of the trip. Upon arrival, steam was issuing from every crevice of the cars. On removing the tank covers, it rushed out in large volumes. The doors were opened and the ice was put in the tanks; the free circulation of cold air then soon cooled the contents of the cars. In unloading it was discovered that some of the two upper layers of boxes were badly damaged by heat, which naturally was the most intense near the top of the cars. No signs of actual combustion were found, but this would probably have occurred in a short time had not the cars been quickly cooled. The temperature must have been nearly up to the burning point, as many of the green stems of the plants were black and brittle.

SEEPAGE OF WATER IN THE EARTH.

All rocks are more porous than glass, and hence the ocean bottom everywhere permits the water, by the force of pressure and capillarity, to seep into the bowels of the earth. The rate of the seepage will depend on the depth of the sea, the porosity of the underlying rock and the temperature. Owing to the pressure at great depths in the earth's crust the rate of seepage would diminish, but it is increased by the effect of high temperature, which causes the steam to diffuse in the earth, just as gases have been found to do in hot steel under experiment. That water readily diffuses and steam is abundantly absorbed in hot rocks is proved by the vast clouds of vapor given off by molten lava as it pours from a volcano. Water, chiefly from the oceans, may seep down into the earth until it comes in contact with hot rocks, then steam develops, and when the accumulation is great enough the earth is shaken till the strata move at the nearest fault lint, of a volcano becomes active. The experiments made in France by the veteran geologist Daubree many years ago show that water and steam may by force of capillarity enter a region of greater counter pressure and actually increase the pressure within, thus accumulating a subterranean strain which will eventually cause an earthquake or a volcanic eruption.

ELEMENTS OF DYNAMO DESIGN.

IRA M. CUSHING.

II. Magnetic Circuits—Field Magnets.

The magnetic circuit has been found to have many properties in common with the electric circuit. There is a difference of magnetic potential causing lines of force to flow from the north to the south pole, just as there is a difference of electric potential between the terminals of a battery. The total power of the magnet or magneto motive-force (M. M. F.) is equal to the sum of the M. M. F. of each turn of the coil, just as the total electromotive force of a battery is the sum of the E. M. F. of each cell when connected in series.

Some materials conduct magnetism better than others, in the same manner that some conduct the electric current better than others. Also, the reluctance, which is the resistance in materials to the passage of magnetism, is proportional to the length of the path, and inversly proportional to the cross section of the path, which is true of the electric circuit.

As stated above, materials have a reluctance to the passage of magnetism, and this is called Reluctivity. The opposite to this is called Permeability. Various definitions have been given for this property, and one of the clearest is as follows:—Permeability is the ability which a material has to transmit magnetizing force, and is expressed numerically as the ratio between the magnetic lines per unit area and the magnetizing force. Let B equal the lines per unit area and the permeability represented by μ then

$$\mu = \frac{B}{H} \quad (3)$$

If a column of air in a coil is given a magnetizing force equal to H, the lines per unit area or flux density will be the same, or in other words, air has a permeability of 1. It has been found by experiment that if a piece of iron is placed in the coil and subjected to the same force H, that the flux density B is much greater. For illustration; if the iron were given a magnetizing force that would produce 10 lines in the air, it would be found to contain 4070 lines per unit area. Then, by dividing the flux density of the iron by what it would be in the air the permeability is found to be 407. That is, the iron has the ability or capacity of carrying 407 more lines per unit area than the air at this density. All non-magnetic materials like paper, coton, brass, etc., are considered as having a permeability of 1.

Continued evperiments brought out the fact that the permeability of iron and steel varied much for different degrees of magnetization. It actually seems as though the magnetic lines occupied space, and there soon comes a point at which the iron becomes saturated and any increase in the flux density requires more power in proportion than it did before saturation was reached. The result of these experiments have been ploted in curves with B for ordinates and H for abscissae. Fig. 5 shows approximately the curves for different irons and steels. These curves show very clearly the point of saturation to be where the curve turns and runs nearly horizontal. They also show that some varieties of steel and iron have a greater capacity than others. For example, soft annealed iron requires nearly three times the flux density that cast iron does to become saturated.

The practical working limit of flux density B in

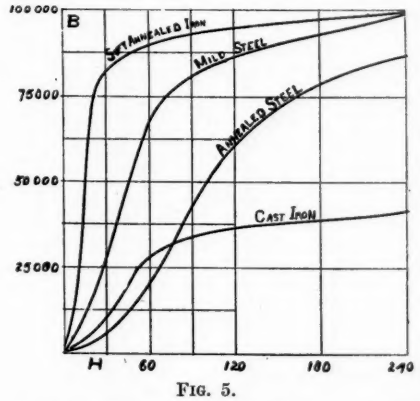


FIG. 5.

good wrought iron is about 125,000 lines per square inch and in cast iron the working limit is reached at about 70,000 lines. However, the permeability of different pieces of the same kind of iron vary so that in extremely nice calculations it is necessary to test the piece to be used. In ordinary work, and especially in small dynamo designs, this degree of nicety is not necessary; there being other points in the design which would have more weight in their variation than this.

Joints in the iron of a magnet circuit seem to add a reluctance, or magnetic resistance, to the lines of force, requiring additional M. M. F. to drive a given number of lines. The exact effects have to be determined experimentally and vary in proportion to the number of lines of force. For a low unit intensity

(H—) the loss due to a joint amounts to about 20 per cent., while with a large density the loss runs as low as 2 per cent. The joint is really a very small air gap, and it is presumed that with the increased magnetic density the resulting attraction of the pieces of iron will reduce the air gap which would account for the decrease in loss. With very high magnetic density, of say 100,000 to 125,000 lines per sq. in., the attraction of one piece to the other at the joint will cause a pressure of approximately 200 lbs. per sq. in.

It is evident that an air gap in a non-magnetic circuit, or a space filled with non-magnetic material, which would have a permeability of 1 would require a considerable increase in M. M. F. to force the same number of lines as in the iron itself. The adjustment of air gaps in dynamos and motors, particularly small ones, needs much care both in designing and making the machines. If a large air gap is present, greater power is needed to force the required lines of force across it, as the evident power is drawn from the armature it is evident that its output is reduced and therefore the efficiency of the machine.

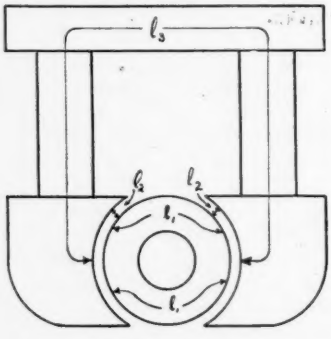


FIG. 6.

As stated before, some magnetic materials retain magnetism after the source has been removed. Illustrations of this are steel, especially hard steel, and hardened irons. These have this property to a large degree. This remaining magnetism is termed Residual Magnetism. The ability of holding residual magnetism is not, however, confined to steel and hard iron. The softest iron will retain a slight amount. This property is a very fortunate one for dynamo designers, as it makes it possible for a dynamo to start generating current without an external application of magnetism to the fields every time the machine is started. This residual magnetism can be removed by reversing the magnetism with a coil of wire or by heating. Reversing the magnetism is uncertain as too strong a force in the opposite direction will produce residual in that direction. Heating iron to a dull or cherry red will remove all traces of the magnetism.

Another magnetic property of iron and steel is Hysteresis. This is a lag in the building up to their full number of the lines of force in the iron behind the force which producees them. In other words, there is an appreciable time between thee application of the force and the building up of the lines to the full number. Hysteresis is much less in soft iron than in steel. Reversals of magnetism take place every revolution of the dynamo, so it is necessary to make the core of as soft a grade of iron as possible. Hysteresis is a loss, and shows itself as heat in the iron, which accounts for some of the heat in the armature core. This, however, is a more important factor in alternating current design, especially transformers, as there large masses of iron are subjected to the reversals.

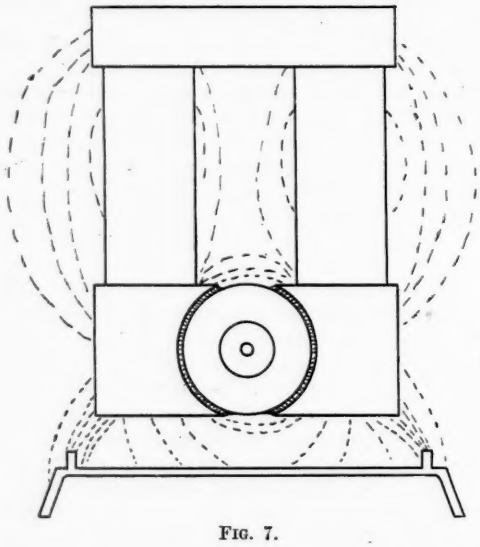


FIG. 7.

Having mastered some of the fundamental principles of magnetism, the field magnet will be the first part of the dynamo to consider although in the actual design of the machine it is the second part to calculate, the armature being the first.

The magneto-motive-force required to drive a given number of lines through an iron core, or across an air gap, depends upon the reluctance of the iron and the number of lines of force. Let H equal the magneto-motive-force, N the total flux, and R the reluctance, then,—

$$H = NR. \quad (4)$$

But from formula (1) $H = k\ I\ S$. then

$$k\ I\ S = NR \quad (5)$$

When the unit of length and area is given in inches k equals $1 \div 0.3132$ therefore the ampere turns

$$I\ S = NR\ 0.3132 \quad (6)$$

It was previously determined that the reluctance of a magnetic circuit varied directly in proportion to its

length and varied inversely to its area and the permeability of the iron, that is,—

$$R = \frac{l}{\mu A}$$

and formula (6) will be,—

$$I S = \frac{N l 0.3132}{\mu A}$$

It will be readily seen from Fig. 6 that the length of the magnetic circuit is divided into at least three parts having different magnetic characteristics. This figure of a simple dynamo in which l^1 represents the average length of the armature magnetic circuit, l^2 the aid gap and l^3 the average length of the lines of force through the field. Then the ampere turns for the armature would be $N\ l^1 \div \mu\ A\ 0.3132$ where μ is the permeability and A the sectional area of the field core. As the permeability of air is 1, the ampere turns for the two air gaps would equal $2\ N\ l_2 \div A_2$ Due to the fact that there is a certain amount of leakage of lines of force around the field poles, which do not enter the armature, the flux will have to be increased by an amount v which varies according to the types of field frame, and the capacity of the dynamo, from 1.1 to 1.4. The ampere turns for the field will therefore equal $v\ N\ l_3 \div \mu\ A\ 0.3132$. The total ampere turns will then equal

$$I S = \frac{N l_1\ 0.3132}{\mu_1\ A_1} + \frac{2\ N l_2\ 0.3132}{A_2} + \frac{N l_3\ 0.3132}{\mu_3\ A_3}$$

or

$$I S = N\ 0.3132 \frac{l}{\mu_1 A_1} + \frac{2 l_2}{A_2} + \frac{l_3 v}{\mu_3 A_3} \quad (9)$$

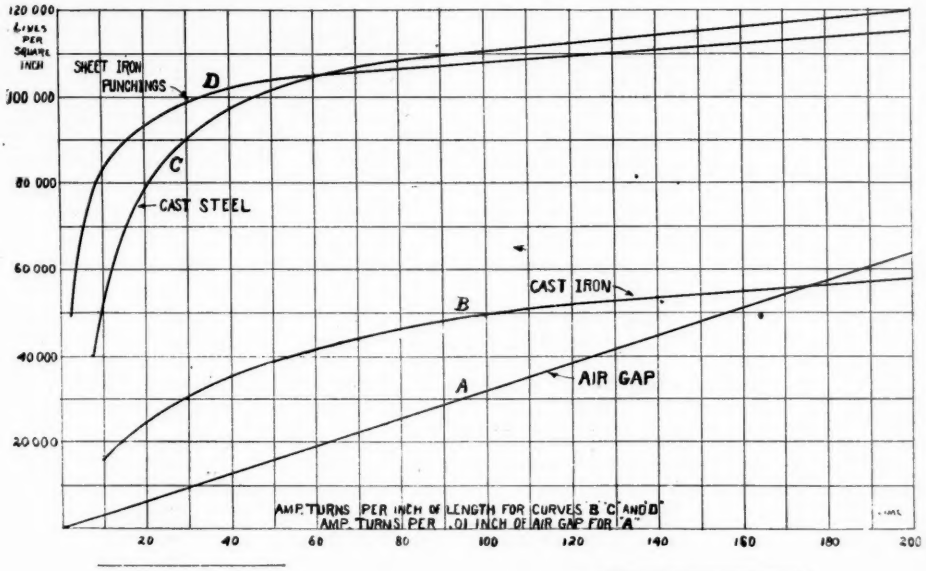
which is the formula to use when length and area is given in inches.

This formula can be presented in another form which may be a little easier to handle. Since $N \div A$ equals the unit density B, then (8) would become I S equals $B\ l\ 0.3132 \div \mu$, and assume S = 1 in., then for each inch of length of the magnetic circuit the ampere turns required will be

$$I S = \frac{B\ 0.3132}{\mu} \quad (10)$$

From this formula can be had two variables, ampere-turns (I. S.) and lines per sq. in., B, and by using these as ordinates and abscissae, a curve can be plotted giving at a glance the ampere turns required for every inch of magnetic circuit, air or iron, with a given magnetic density. Such a curve is given in plate I. Curve A is laid off with ampere turns per .01 inch of air gap for ordinates, and lines per sq. in. for abscissae. Curves B, C, and D are for iron, cast steel and armature punchings respectively, and are laid off with ampere turns per inch of magnetic path as abscissae and lines per square inch as ordinates. These curves should be used with some allowances to make up for variations in the grade of the iron or steel. It is not desirable to work too fine with the numbers, as the results given by these curves are only approximate. Use round numbers. For example, if the curve gave 2523. lines call it 2600; or if 122 1/2 ampere turns are the result of computation make it 125. Liberality of design in this part of the machine will be of great benefit and will help make up difficiencies in other parts.

The form of the field magnet does not matter if it is magnetically and mechanically correct. All parts car-



rying lines of force should be so designed that they will not offer too much resistance to the magnetism (reluctance), but at the same time should not be so large as to add unnecessary weight to the dynamo and look clumsy. Care should also be used to cut down as much as possible the leakage of lines of force around the armature. These lines would be useless and at the same time would require an extra number of ampere turns above those needed to send the lines through the armature.

An example of bad design in this respect would be to carry the field pole tips well around the armature until they nearly touched. This would allow probably nearly 40 per cent. of the total lines in the field

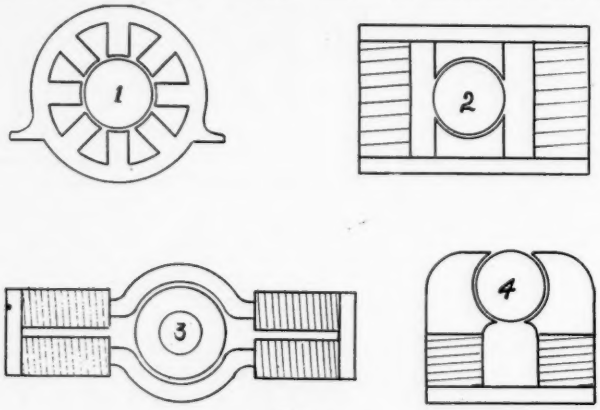


FIG. 8.

to jump across in the air, instead of going through the armature, which is usually crowded to nearly its saturation point. In such a design, therefore, it would be necessary to add 40 per cent. more ampere turns than were actually needed by the armature. In all cases, however, there is a certain amount of leakage of the lines, which either jump from pole to pole in the air, or get back to the other end of the field spool through the air outside the coil. Fig. 7 gives the outline of a dynamo with the leakage shown in dark lines. This is the old familiar Edison type dynamo. It is mounted on a wooden base, which in turn rests on an iron bed plate with sliding rails. The figure shows plainly how many lines are lost in the air, and also that many pass from pole to pole through the bed plate. This type of field is very wasteful of magnetism.

The modern multipolar dynamo is designed to obviate as much as possible this leakage. This type is shown in No. 1, Fig 8. The field poles point inward towards the armature from a solid iron ring which forms part of the magnetic path, the completion of the path being through the armature when it is needed. It will be seen that the iron forms nearly the shortest path for the lines of force. There is, however, a slight leakage from pole tip to pole tip in the air. This is taken care of in formula 9 by the letter V as explained before.

The application of these formulae will be treated in later chapters. The size of wire depends upon the amount of current flowing. The determination of these will also be taken up later, and a table will be given showing the current capacity, diameter of bare wire and with insulation for the different sizes of wire.

There are a number of rules given for determining the direction of the flow of magnetism induced by an electric current. Ampere's Rule, which follows, shows the direction of the field of force which surrounds a current flowing in a conductor. "Suppose a man swimming in the wire with the current, and that he turns (his body) so as to face a (compass) needle, then the N seeking pole of the needle will be deflected towards his left hand." In other words, in facing the direction a current is flowing in a conductor, the lines of force pass around the conductor clock wire, or in the direction the hands of a clock move. If this conductor be multiplied into a number of conductors so as to make a coil, and the current in passing along the wire comes up in front and over the top of the coil away from the observer, it is very evident that all the lines from each conductor added together will make a north pole at the left and a south pole at the right. Also, if the current passes down and under the coil away from the observer the north pole will be at the right and the south pole at the left.

Another good rule is this:—Facing a North pole, the magnetizing current would be flowing about it in a counter-clock-wise direction, and facing a South pole the magnetizing current would be flowing in a clock wise direction . If the direction of current is known (which is generally the case), this rule can be used, for if the observer is facing the end of an electro-magnet and finds the current flowing clock-wise,

then the nearest end of the magnet is the South pole. Similarly, if the current is flowing counter-clock-wise the nearest pole is North. With these rules, it makes no difference in which direction the current passes along the spiral; that is, it matters not whether the coil is wound right or left handed. These rules are very important and should be memorized.

The forms of field frames are many, and it matters but little what form is used provided it is designed for a minimum leakage, and that the coils have sufficient copper wire to produce the required field of force for the armature. Fig. 8 gives a few standard forms; No. 1 is the multipolar form, which is used almost exclusively at the present time for medium and large size generators. The familiar Edison bipolar is shown in Figs. 6 and 7. Refering to Fig. 8 again, form No. 2 is the Manchester type; No. 3 is an early form of Siemen's dynamo; No. 4 is a favorite type of the present day with some manufacturers for small size machines. It is practically the Edison bipolar inverted, which removes the objectional leakage of magnetism in the base frame. In deciding upon a field frame it is obvious that one with the least number of joints in the magnetic path will require less field excitation and therefore give a dynamo of greater efficiency.

The subject of the field magnet and frame is not by any means exhausted in the foregoing but has only been touched upon. Much has been written on the subject, more in fact than the average student can read. In a later chapter a list of books will be given which the student may examine and study those portion referring to the work at hand.

NEW BOOKS RECEIVED.

ELECTRICAL WIRING AND CONSTRUCTION TABLES. Menry C. Horstman and Victor H. Tousley, 118 pp. 6x4 in. Full Flexible Morocco, $1.50. Frederick J. Drake & Co., Chicago, Ill.

This book, which is a companion volume to "Modern Wiring Diagrams," is a pocket hand-book that would be of especial value to inside wiremen and to them presents material that should be of considerable benefit. It is a very good interpretation of that bewildering "Natural Electrical Code." For direct current work and data on wire and wiring material it seems to be complete enough for those who should use it. With regard to the alternating current part, the book seems to be unfortunately lacking in some things. The selection of voltages for the motor charts does not correspond to the present practice. Very little work is being done with 440 volts. This has been raised to 550 or 600 volts. The 1000-volt chart should have been worked out for 1150 volts, but even this is being superceded by the almost universal use of 2300 volts for high tension transmission in cities. No table is given for this latter voltage. The size of wire can be approximated, however, for these voltages from the data given, but this book does not tell how.

A little data on pole line work is given but not enough to be of any great value. Nothing is said about the dimensions of poles, cross-arms, fins, insulators, etc.

The alternating current formulae are of no great value to the user of the book as some of the factors in them would require a considerable knowledge in mathematics to determine and no tables are given from which these could be obtained. These factors are "P. F. for power factor of load;" "I. F. for inductance factor or sine of angle of lag;" "L. for inductive drop in line." Power factor is a derived quantity which cannot be determined except under actual working conditions and it varies constantly. For all practical purposes, however, it can be approximated by those having experience. "Inductance factor" and "inductive drop" require careful computation.

In formulae given for current in conductors (alternating) the factor W is used to represent watts. No mention is made as to whether this is indicated or recorded watts. As a matter of fact indicated watts are used. These same formulae use P. F. (power factor) as one of the elements in the equation. It would be much easier for the worker to read the current, volts and indicated watts than try to find out the power factor.

A table near the last of the book gives full load currents for motors, but does not state whether for A. C. or D. C.

The book is very well indexed and except for the few things mentioned should be a great help to wiremen and wiring contractors.

ALTERNATING CURRENT MOTORS. A. S. McAllister, Ph. D., 278 pp. 9x6 in. 122 illustrations. Cloth, $3.00. McGraw Publishing Co., New York.

Readers of the Electrical World, American Electrician (now combined with the Elec. World and Eng.) and the Sibley Journal of Engineering will be very glad to know that Mr. McAllister's articles on alternating current motors, which appeared at various times in the above publications, have now been collected and published in book form. Those not familiar with the articles cannot afford to lose the opportunity to obtain and study this book very carefully.

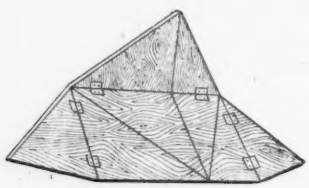
The increasing use of alternating current, due to the ease of transmission and raising and lowering, makes it imperative that some form of apparatus be used whereby the alternating electric power can be changed into mechanical power. The more knowledge there is to be had on this apparatus, the more intelligently and advantageously can it be used. The apparatus now most extensively used is the alternating motor. Too little is known about these outside the designing rooms of the motor manufactures.

This book is a long stride in the direction of a clearer understanding of the alternating current motor, and in this catagory is included the alternating current commutating motor and rotary converter. It is technical and assumes that the reader is familiar with the lower branches of mathematics, electricity and magnetism, and also the graphic method of representing alternating voltages, currents, etc. The book is not so technical, however, but what the average electrical engineer can thoroughly understand and follow clearly the theory and formulae derivations.

The volume is very well indexed and should make very valuable reference book. It should not only be in every electrical engineer's library, but should be carefully studied. All libraries having technical books should have it on their shelves for the use of those unable to pay the moderate price.

GEOMETRY IN WOOD.

Richard Inwards, a correspondent of the "English Mechanic," contributes to that journal some particulars of a suggestive model designed for the improvement of the student's knowledge of practical geometry. He says that a new technical school is to be furnished with such models, and that the use of these is not to prove but to exhibit the facts and that furthermore, if the students are set to work on triangles of different proportions they must be dull indeed if they do not absorb the facts.



It will be seen that the triangle is cut up and the parts hinged together to show that triangles can be folded to make two parallelograms. The model is expected to impress the following facts upon the pupil: That all the angles of a triangle make 180 degrees, or two right angles when added together; that any triangle can be divided into two rectangles; that any triangle can be measured by multiplying its base by half its height; "any boy can understand the measurement of a rectangle," pointedly remarks Mr. Inwards, and that any triangle can be divided into two right-angled triangles.

TEMPERING HIGH SPEED STEEL.

At a recent meeting of the Master Blacksmiths' Association, Mr. George Lindsay, in discussing annealing of high speed steel, said he had been called upon to make a forging of this material at short notice and it occurred to him that, if the exclusion of air was the most important thing in the process, it would be well to try a lead bath. Accordingly, a piece of 4-in. pipe about 12 in. long was welded solid at one end to form the pot, which was filled two-thirds full of lead. The lead and the pot were raised to a high temperature, the steel was placed in it and they were allowed to cool together. After it had cooled down to the melting point of lead, or about 630 deg. Fahr., it was reheated sufficiently to remove the steel, which was then allowed to cool slowly. After this treatment it could be cut, in a lathe, like ordinary carbon steel. The suggestion is made as a convenient shop wrinkle.

The same speaker said that in hardening this peculiar metal it was necessary to forge it, lay it down to cool and then heat it again, but not far back from the cutting edge. Great care must be taken in the heating, notwithstanding the common opinion that it cannot be made too hot. Too rapid heating is apt to fuse the edges, so that they will become brittle and crumble. The steel should be given time to absorb the heat. Another danger in rapid heating is that the blast is apt to get through the coke of the fire and oxidize the edges. When the tool is removed from the fire the scale should be carefully removed and the air applied at the back, especially in the case of lathe tools. For milling cutters, taps, reamers and similar tools, where long and slow heating is required, a furnace is almost indispensable, though hollow fires may be made to do good work. An oil bath should be used for cooling, and the temper drawn as in carbon steel.—"Railway Gazette."

The use of soapy water as a lubricant for air-cylinders is recognized as good practice, says the "Mining Press." Even where oil is used as the regular lubricant, soapsuds should be fed in from time to time to clean out the valves and discharge ports. There are many well-authenticated cases in which only soapy water is used as the lubricant. Soapsuds and Dixon's flake graphite mixed make an ideal lubricant for air-cylinders, for by the addition of graphite far less soapy water is necessary than would otherwise be required. Hand oil pumps will pass soapsuds and graphite perfectly satisfactorily, or the graphite may be fed separately in a dry state through a separate cup, while the soapy water passes through the regular lubricators. There is only one caution necessary in this method, namely, to introduce sufficient oil before shutting down the compressor to prevent rusting of the cylinders and valves when the machine remains idle. Rust, however, forms very much less rapidly in the presence of graphite than upon surfaces not thus coated—in fact, it cannot form at all upon a surface completely covered with a film of graphite.